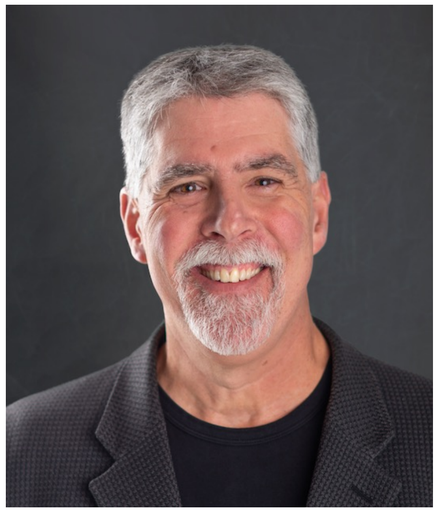
O'REILLY®

LIVE ONLINE TRAINING

Mastering Patterns in Event-Driven Architecture



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Hands-on Software Architect / Published Author

Founder, DeveloperToArchitect.com

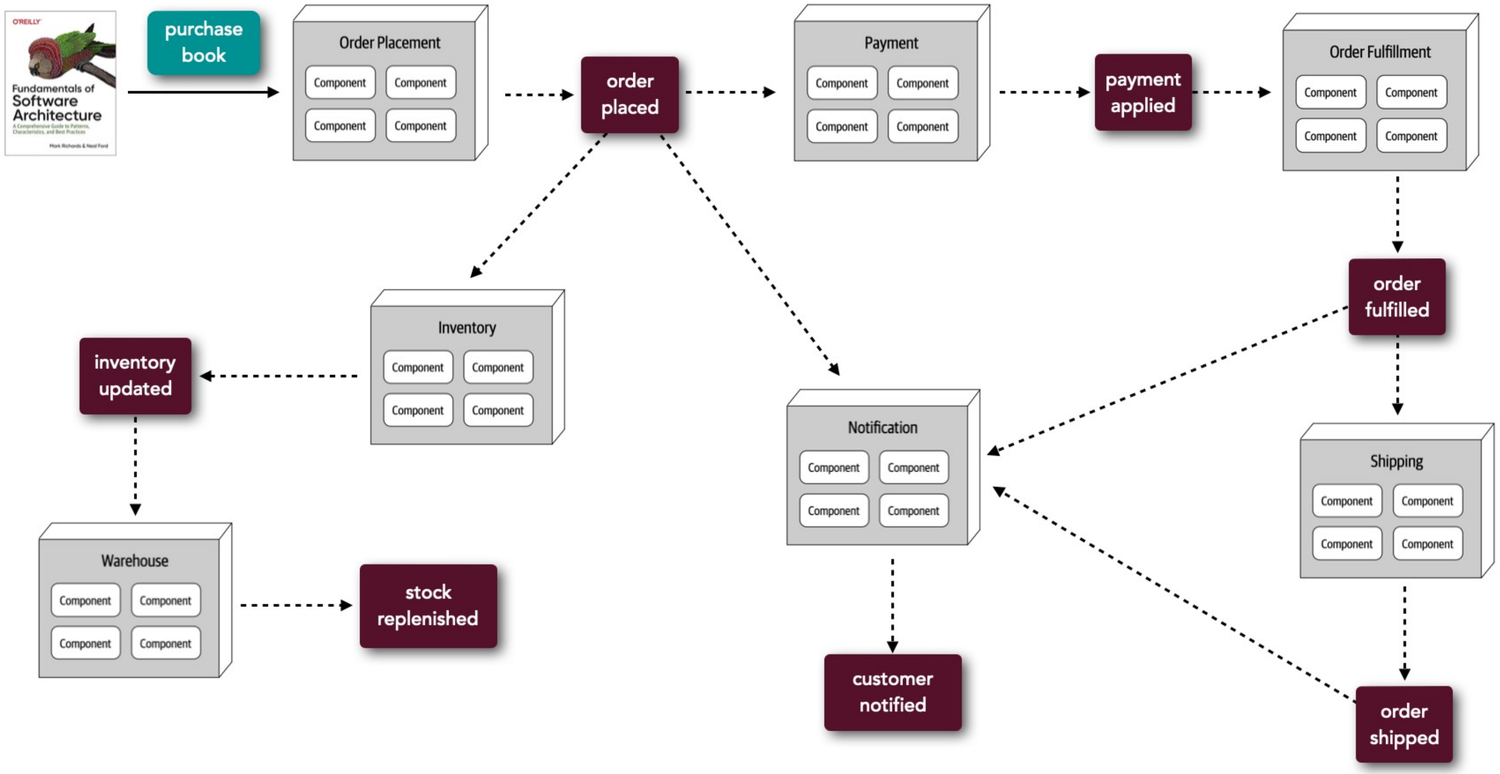
https://www.linkedin.com/in/markrichards3

@markrichardssa

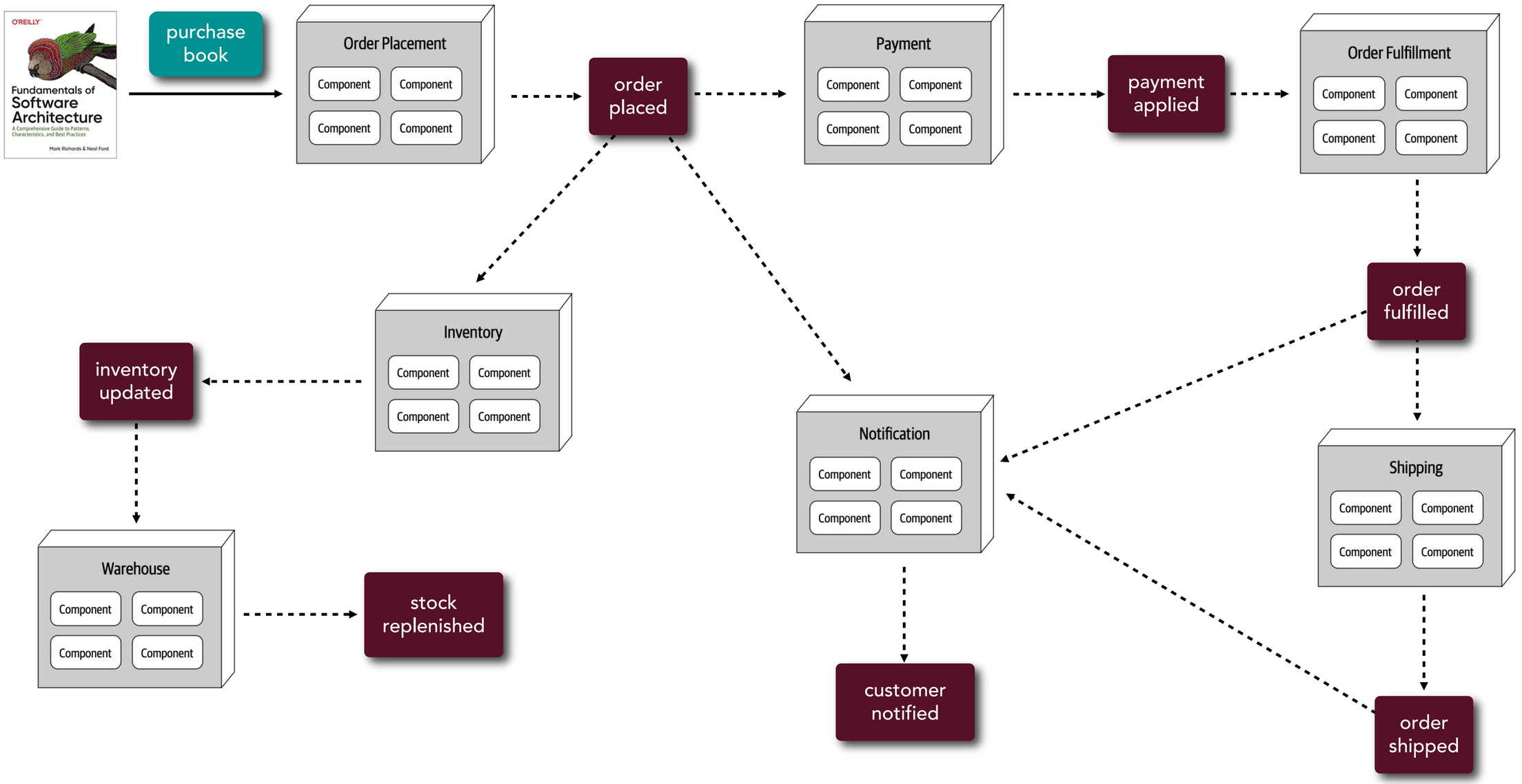
v5a

event-driven architecture

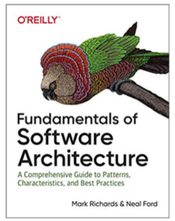
architecture style that leverages asynchronous processing to trigger and respond to events within the system



event-driven architecture

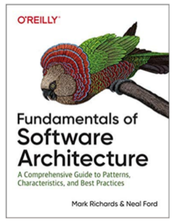


event-driven architecture



purchase book

event-driven architecture



purchase book

order placed

payment applied

order fulfilled

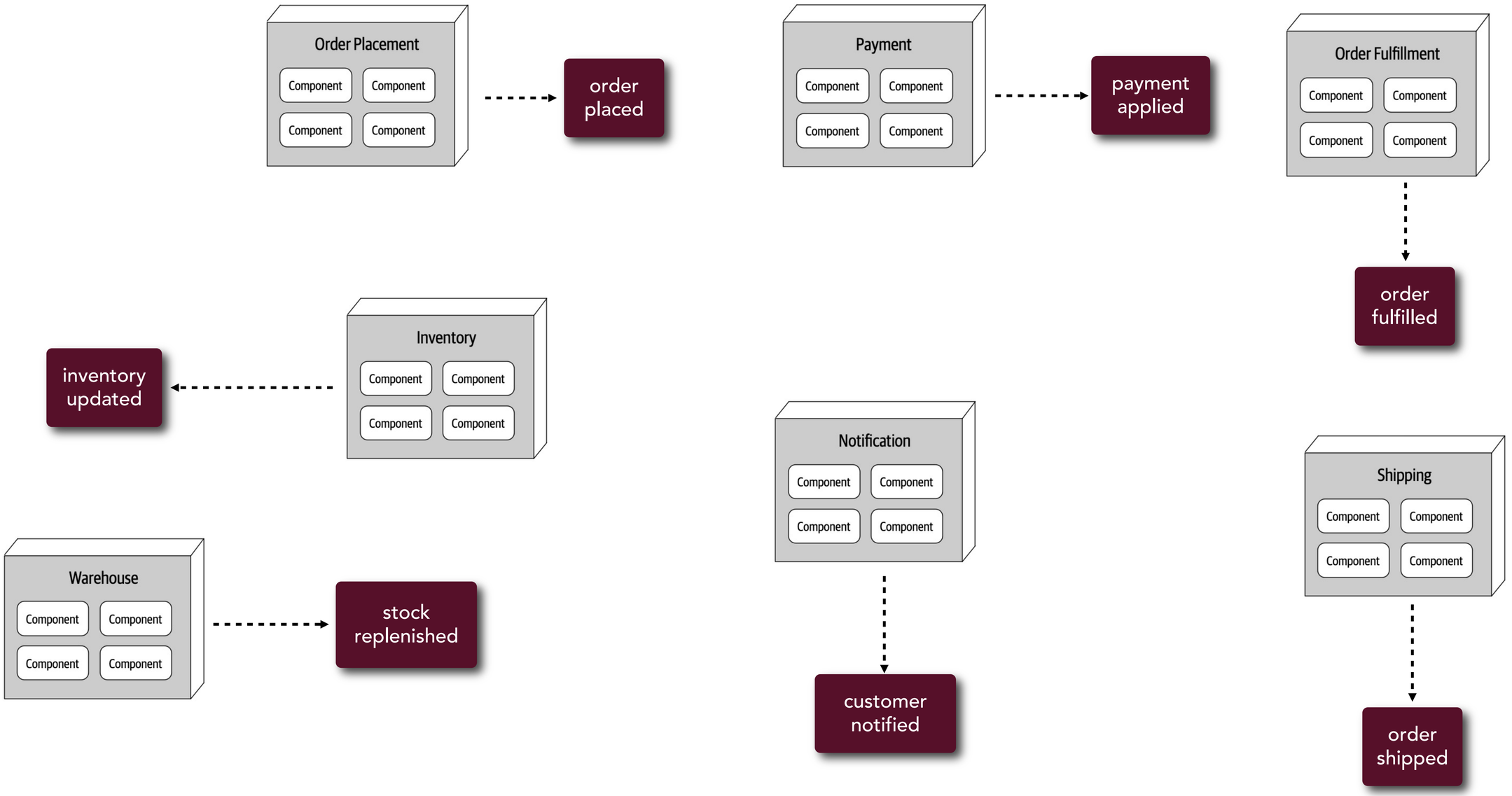
inventory updated

stock replenished

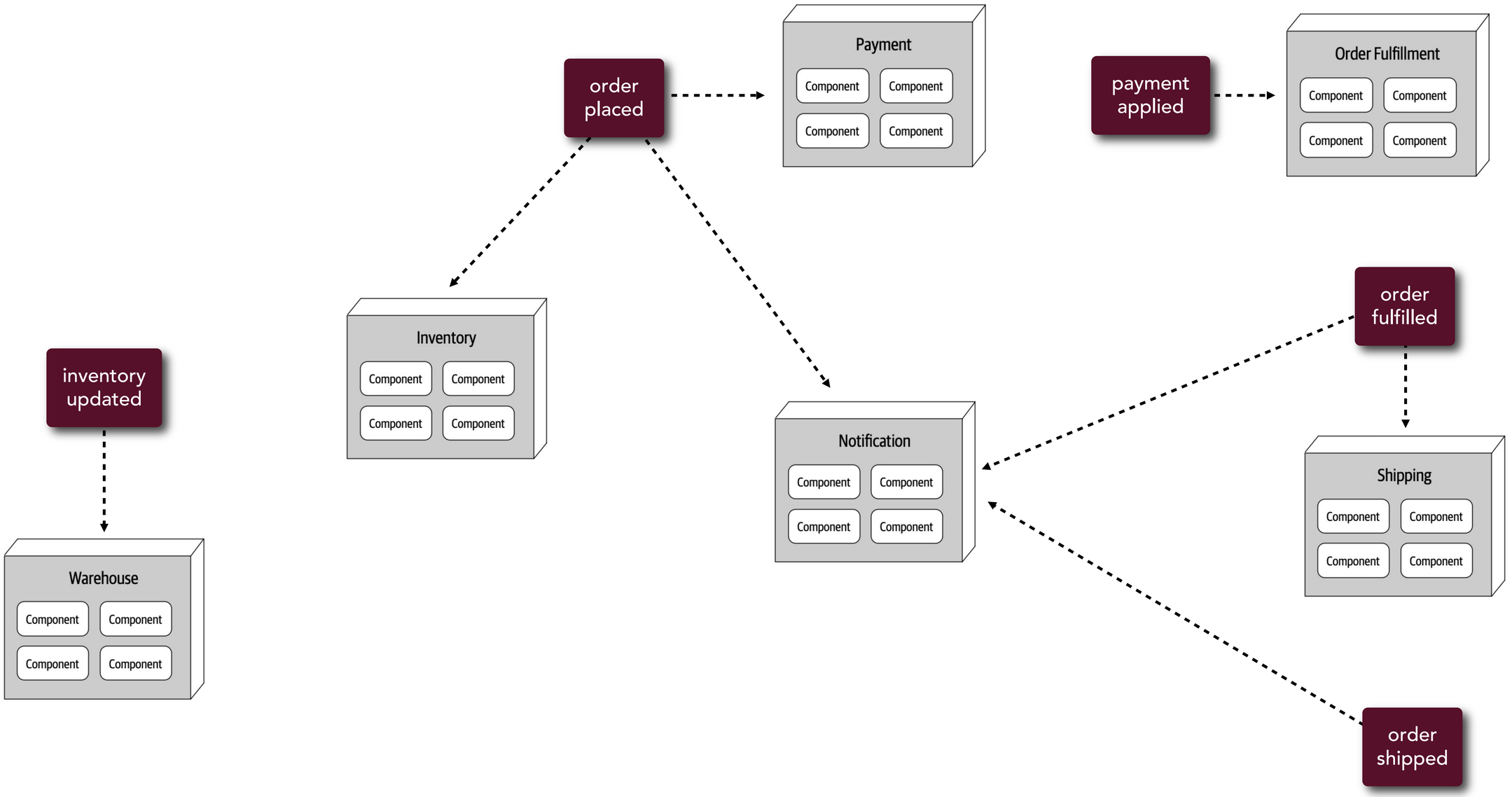
customer notified

order shipped

event-driven architecture

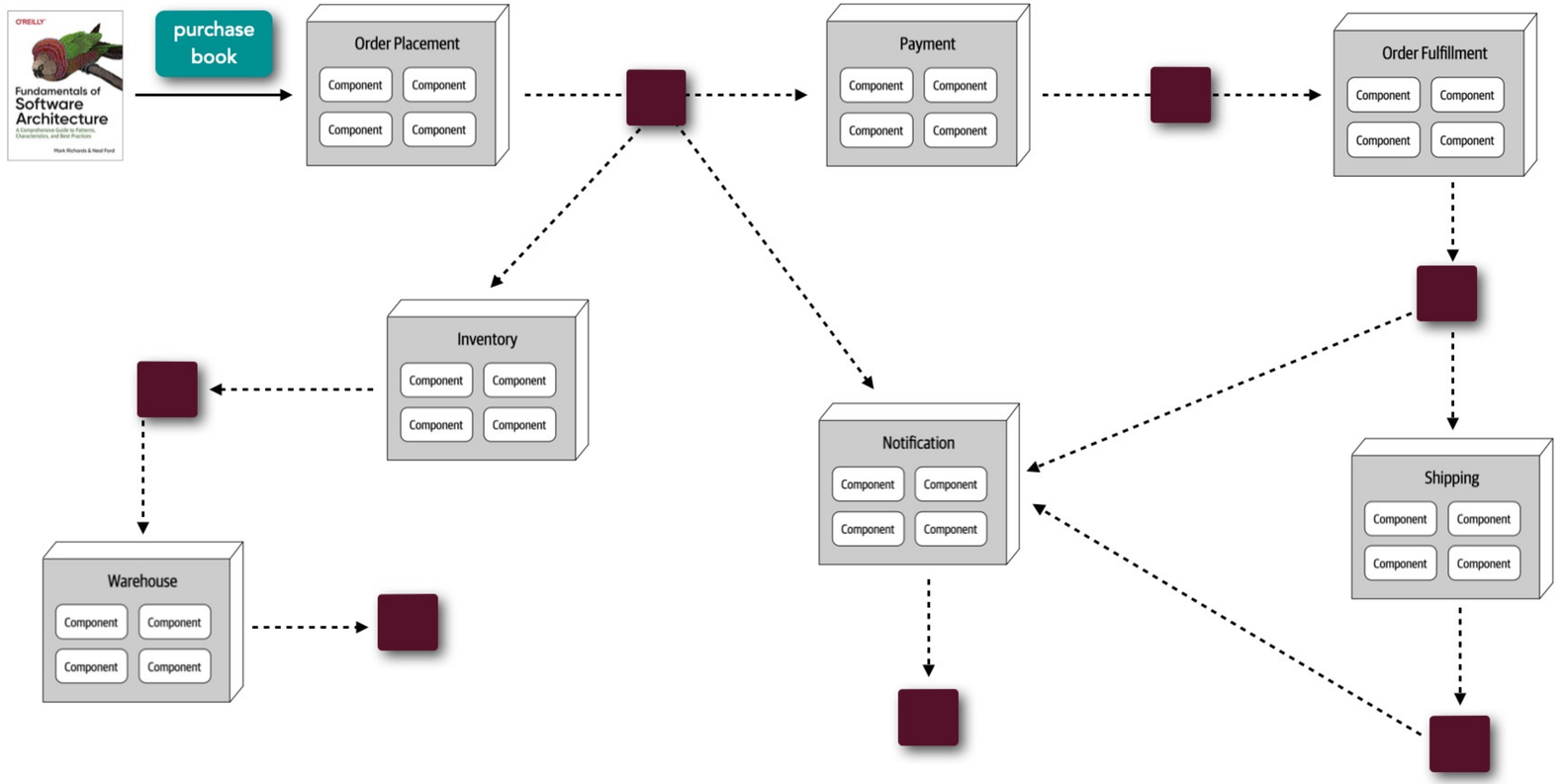


event-driven architecture



event-driven architecture

it's as simple as that! just sprinkle a bit of SQS here, a bit of SNS there…



event-driven architecture

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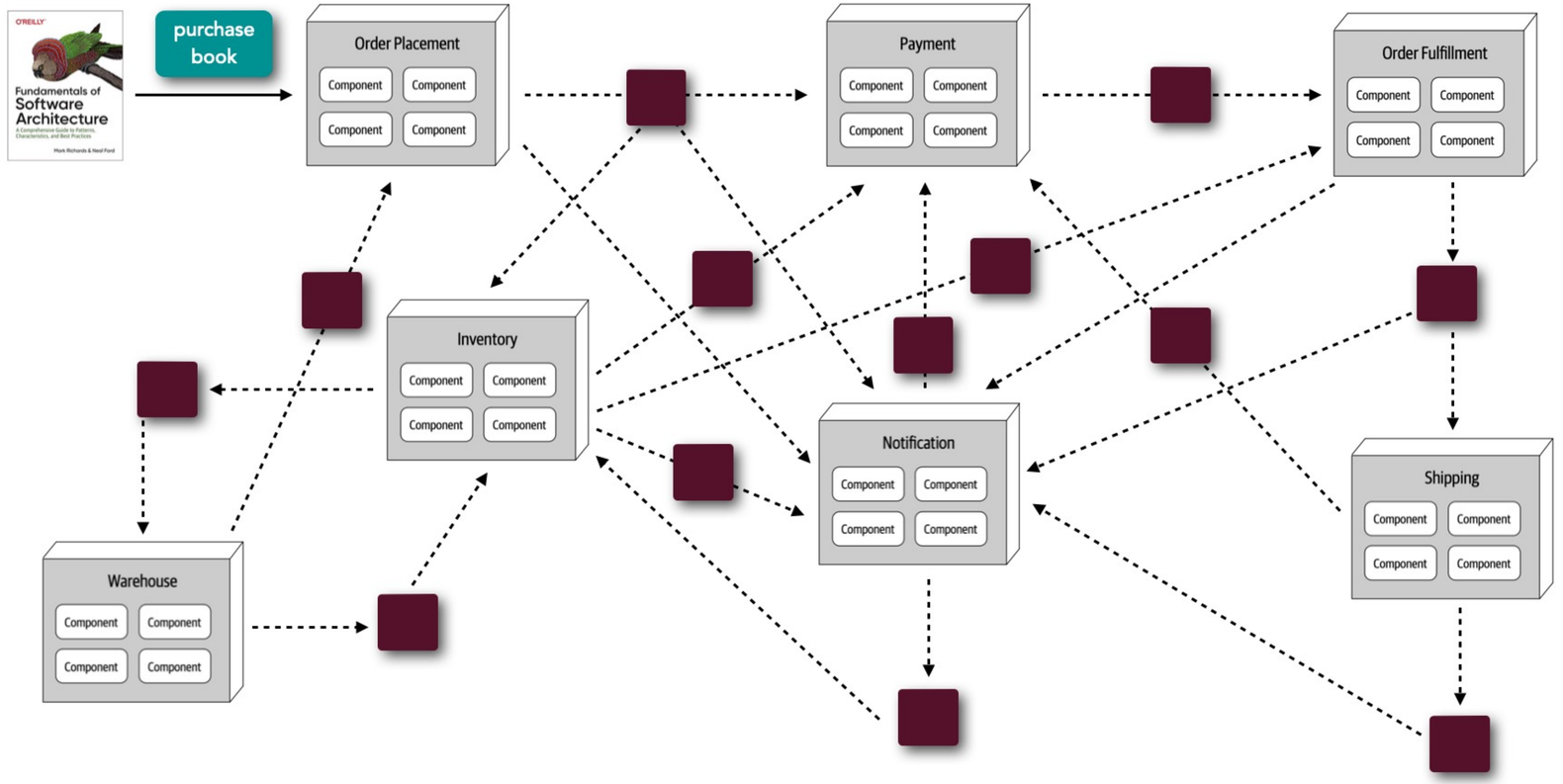
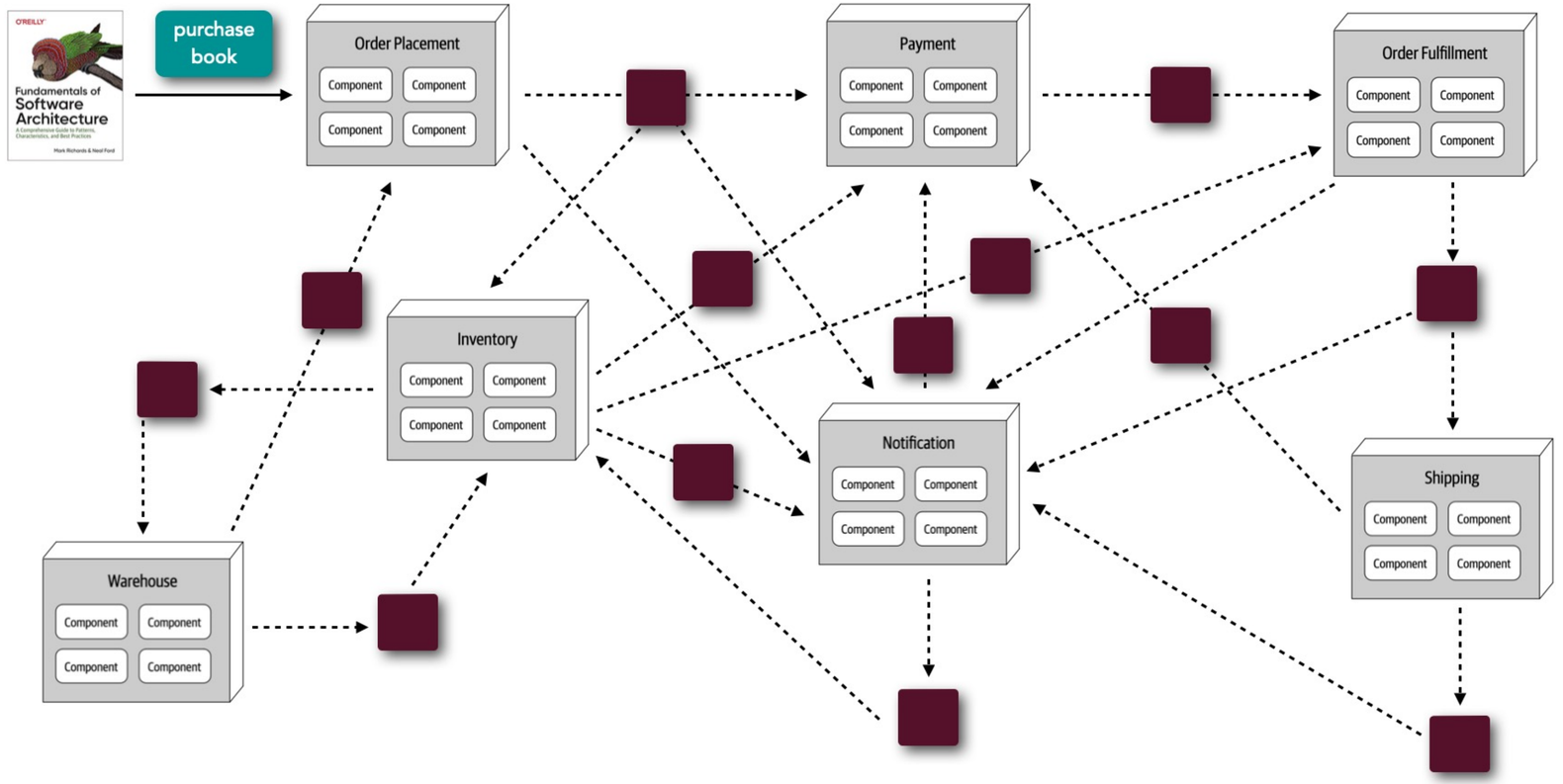


event-driven architecture

~~*it's as simple as that! just sprinkle a bit of SQS here, a bit of SNS there…*~~



event-driven architecture

advantages

disadvantages

event-driven architecture

advantages

- ✓ decoupling
- ✓ scalability
- ✓ fault tolerance
- ✓ responsiveness
- ✓ overall agility

event-driven architecture

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- ✓ decoupling
- ✓ scalability
- ✓ fault tolerance
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disadvantages

- ✗ error handling
- ✗ workflow control
- ✗ event timing
- ✗ contract coupling
- ✗ scenario testing

event-driven architecture

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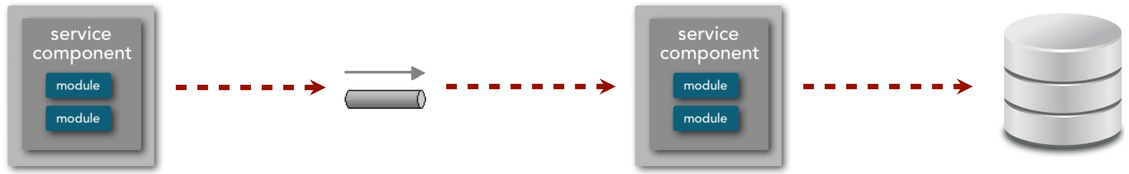
increased complexity!

agenda

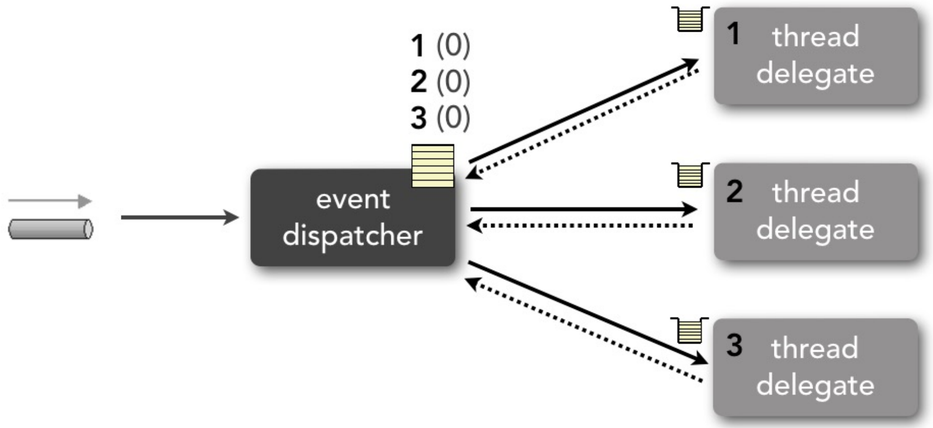
agenda

“how do I guarantee that no messages are lost when passing data from one service to another?”



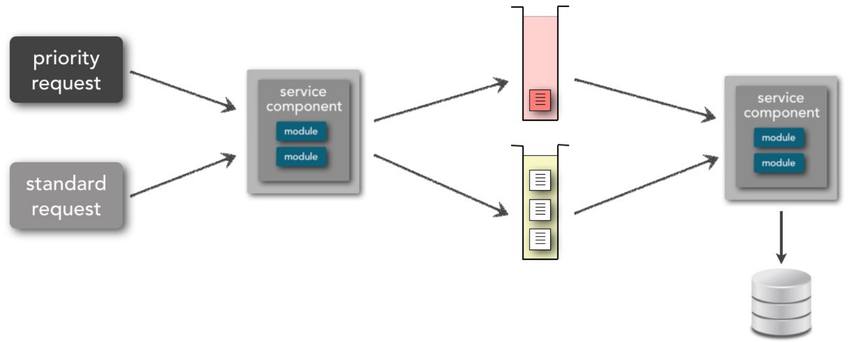
agenda

“how do I increase performance and throughput while still maintaining message processing order?”



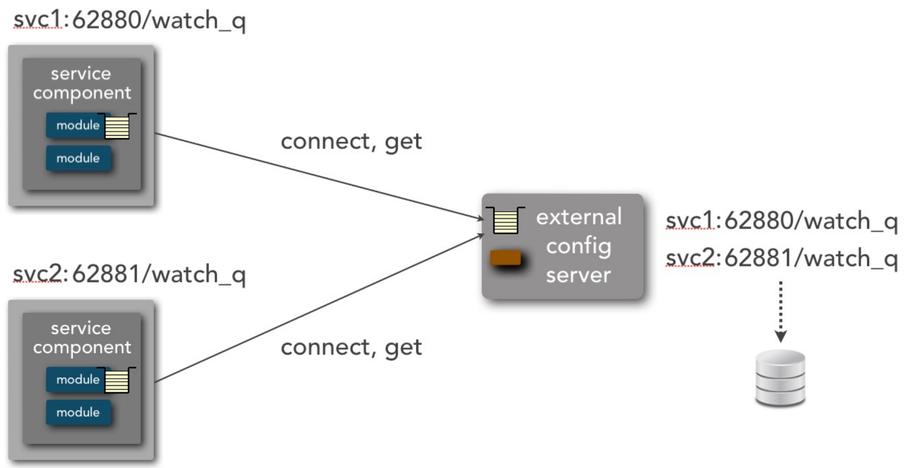
agenda

“how do I give some events a higher priority and still maintain responsiveness for all other events?”



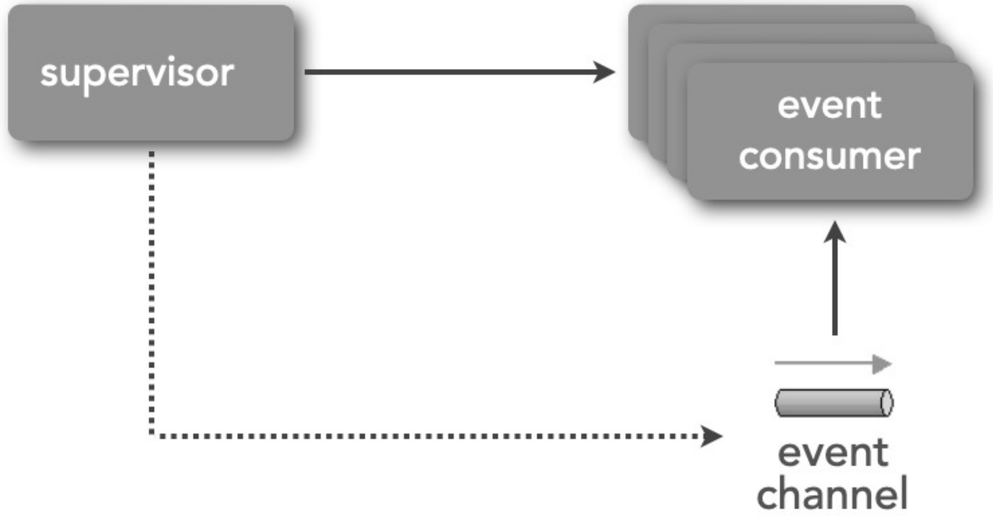
agenda

"how do I send notification events to services without maintaining a persistent connection to those services?"



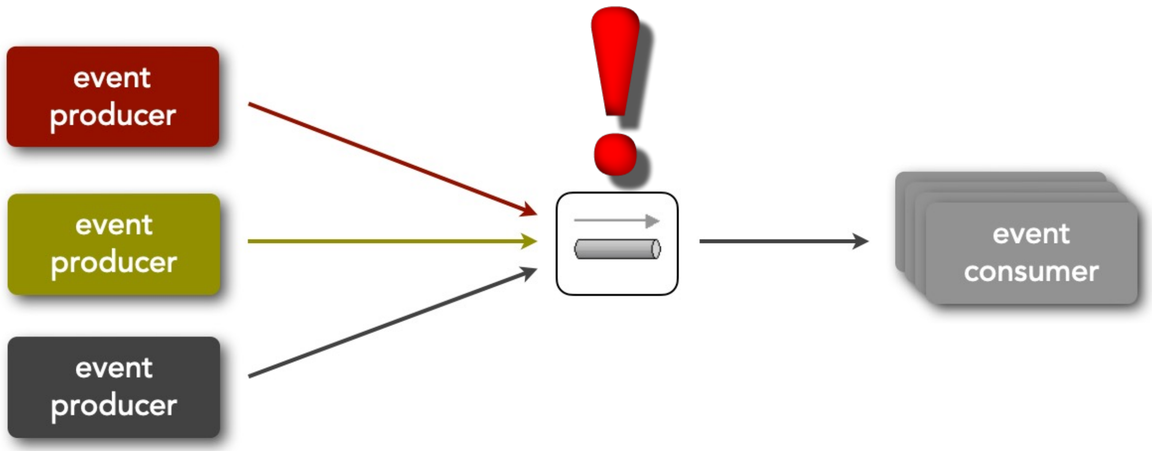
agenda

"how do I handle varying request load and still maintain a consistent response time?"



agenda

"how do I increase the throughput and capacity of events through the system?"



the tradeoffs…

the tradeoffs…

the good things

the tradeoffs…

the bad things

source code

https://github.com/wmr513/event-driven-patterns

https://github.com/wmr513/reactive

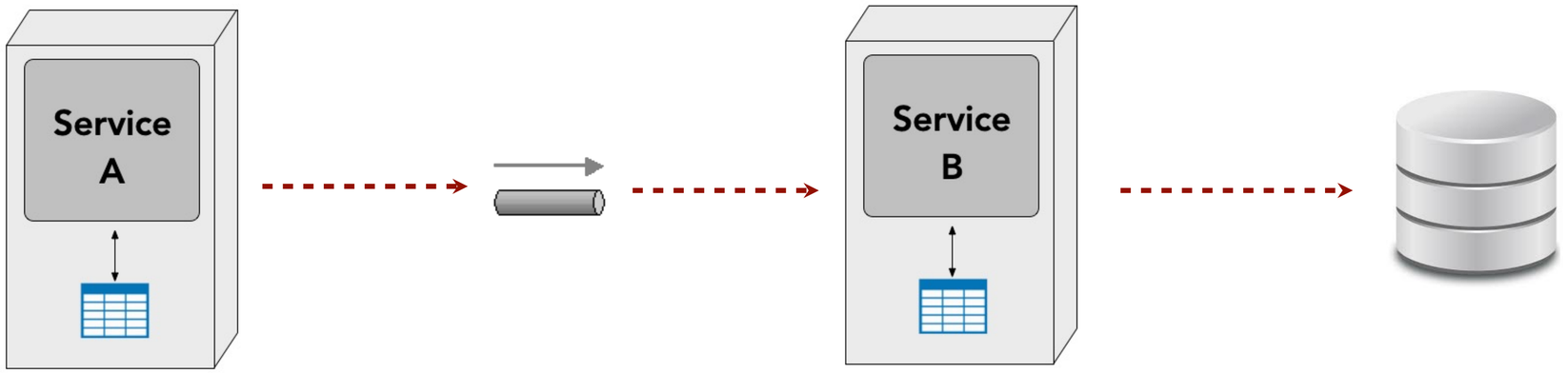
Event Forwarding Pattern

event forwarding pattern

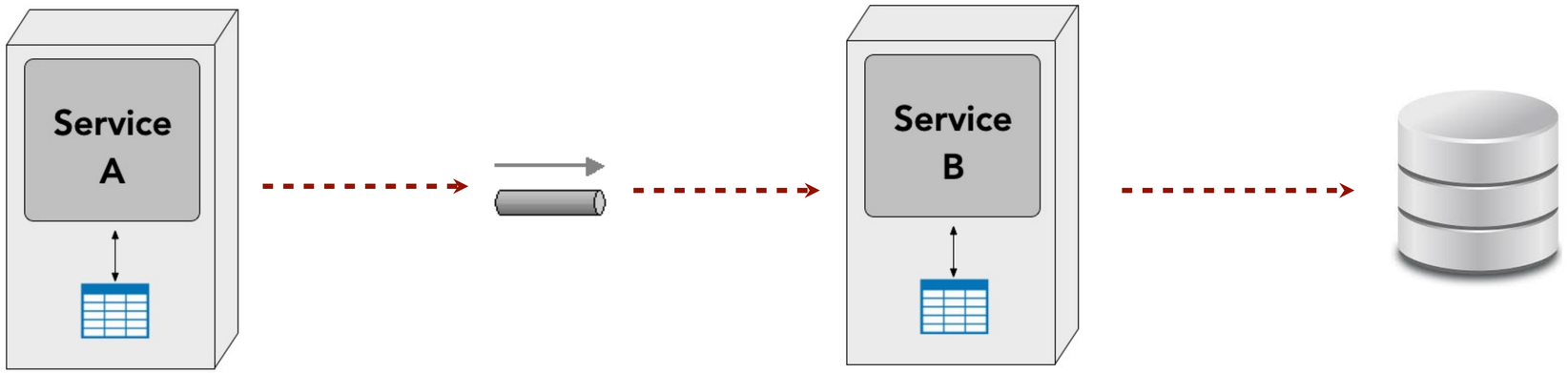
https://github.com/wmr513/event-driven-patterns/tree/master/eventforwarding

event forwarding pattern

"how do I guarantee that no messages are lost when passing data from one service to another?"



event forwarding pattern



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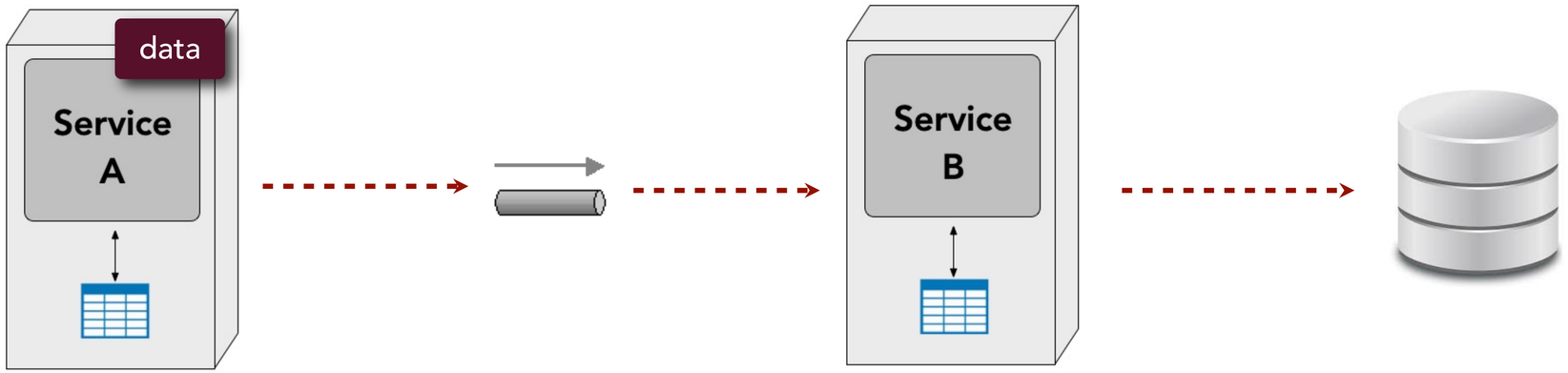

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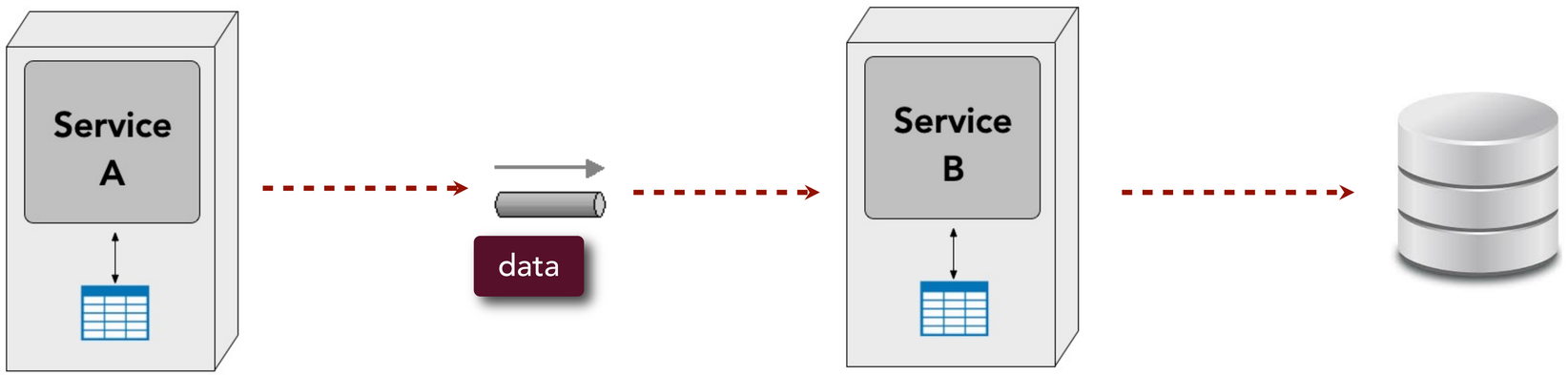

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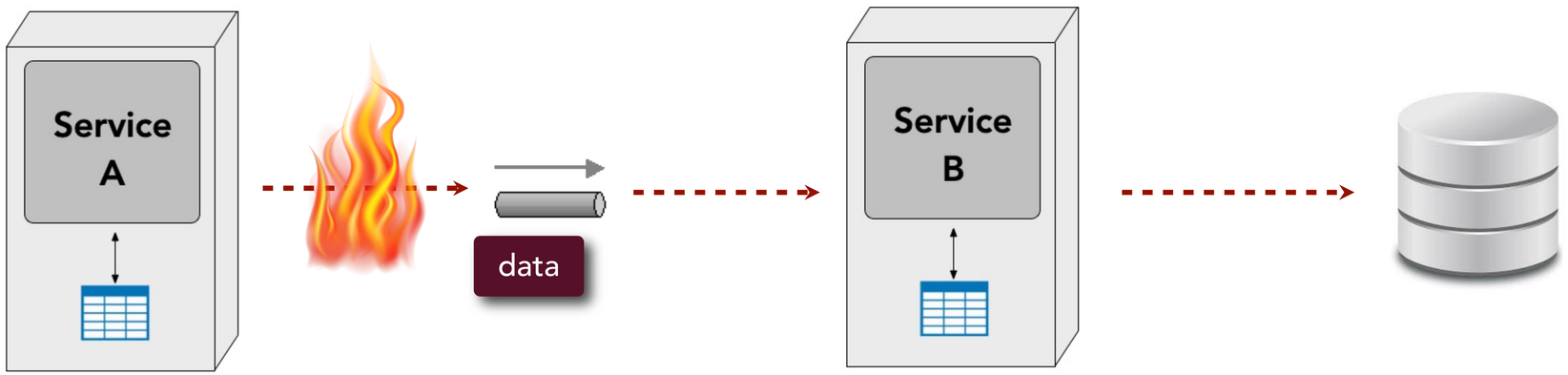

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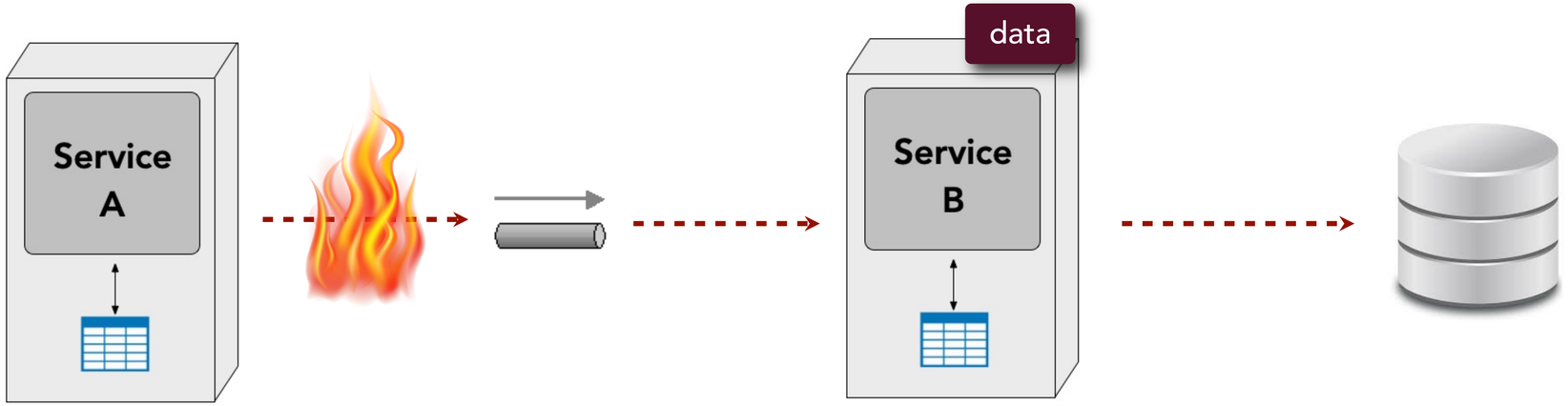

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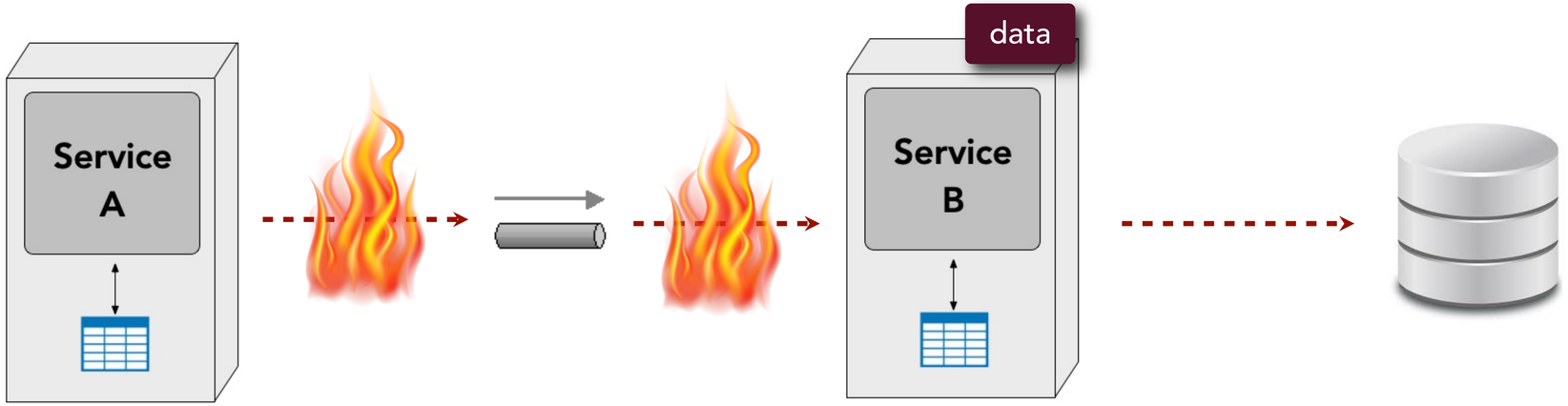

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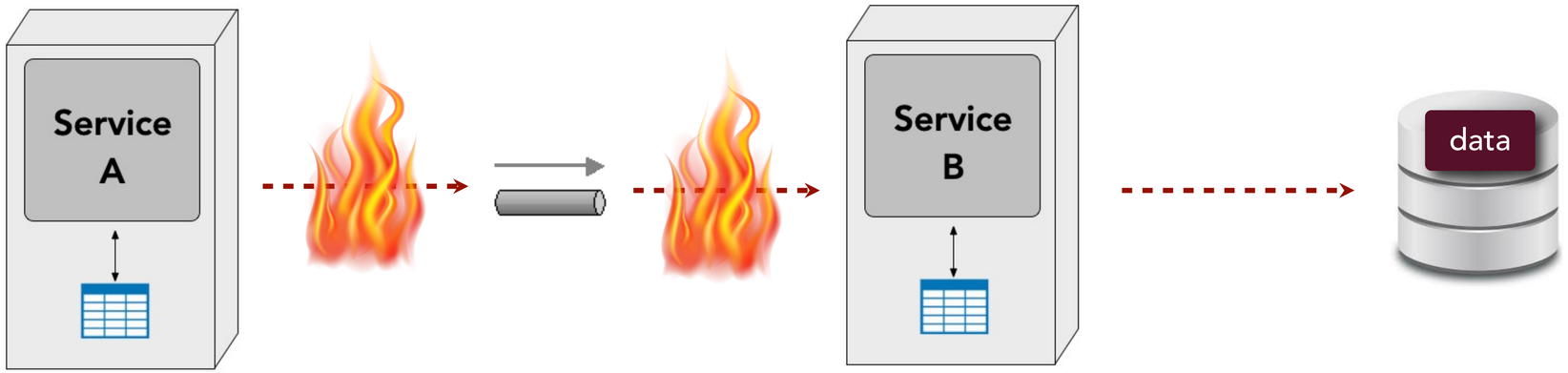

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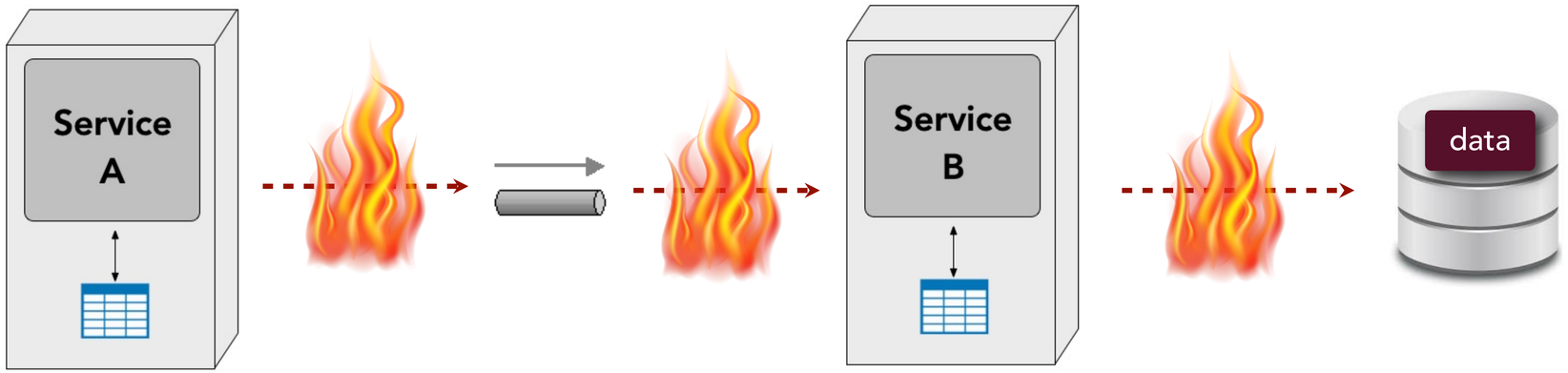

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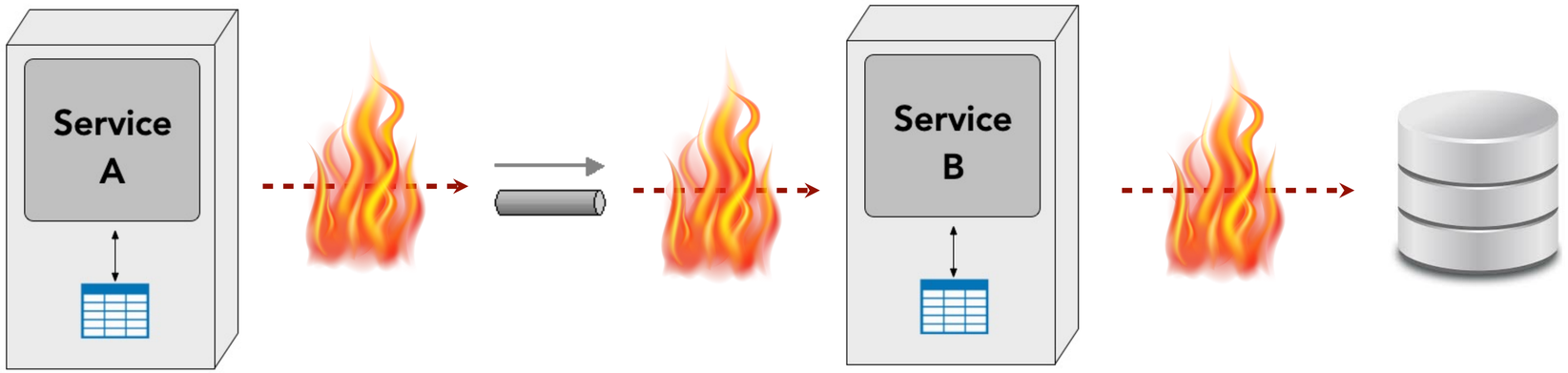

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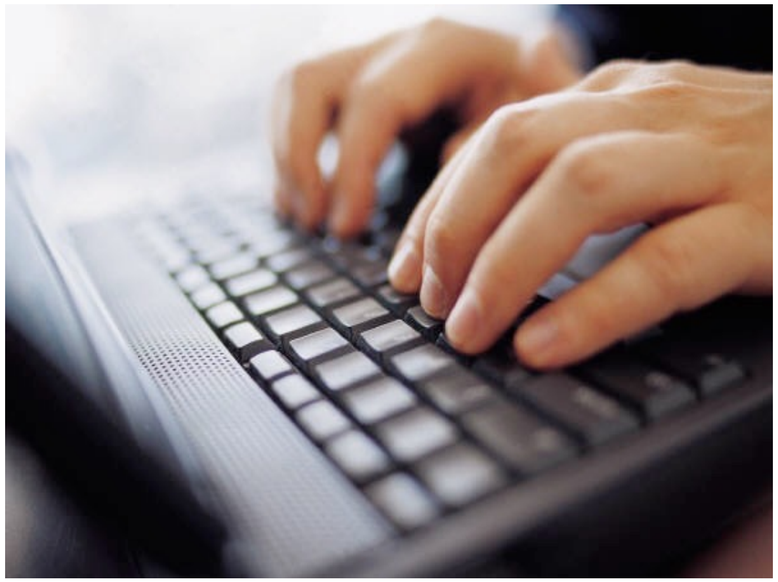
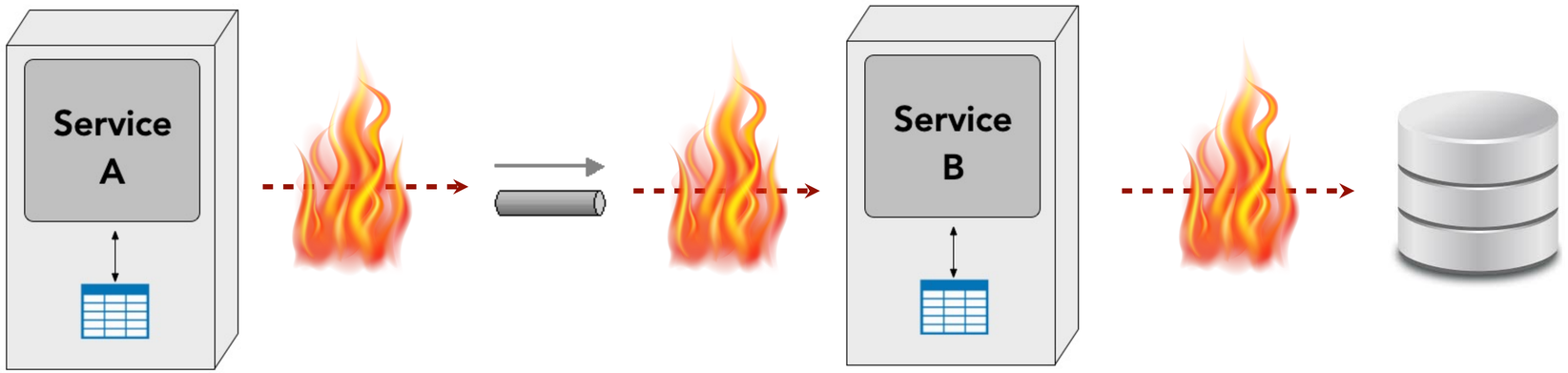
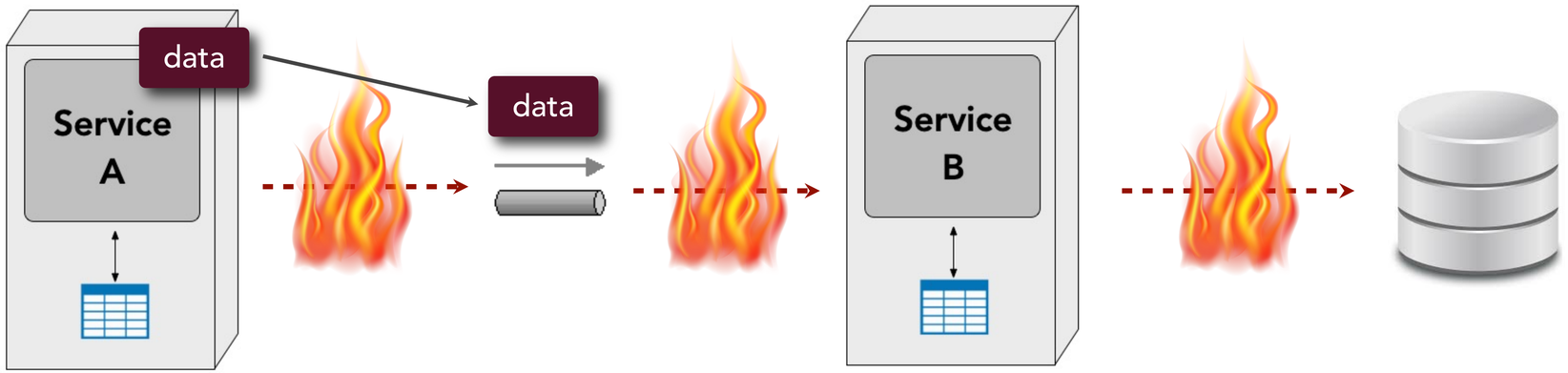


let’s see the issue…

event forwarding pattern



event forwarding pattern



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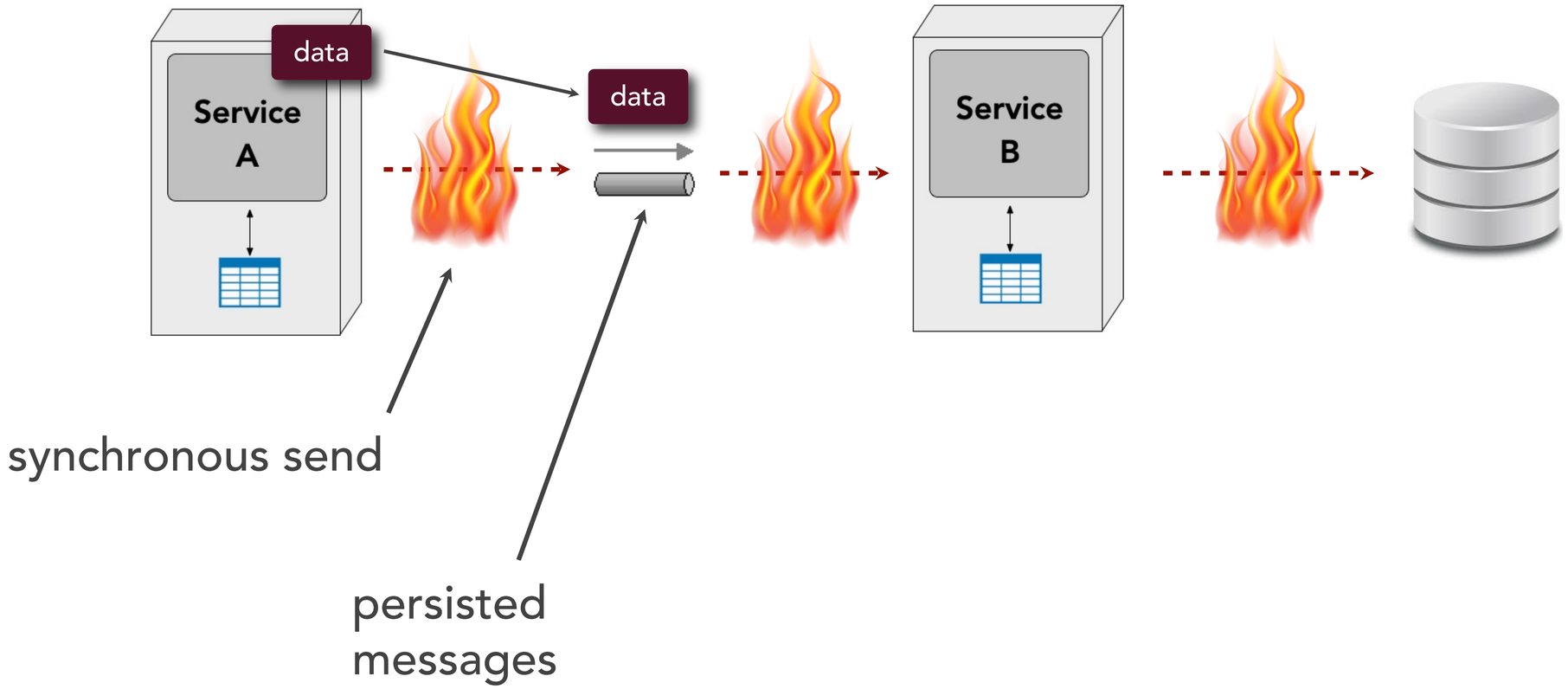

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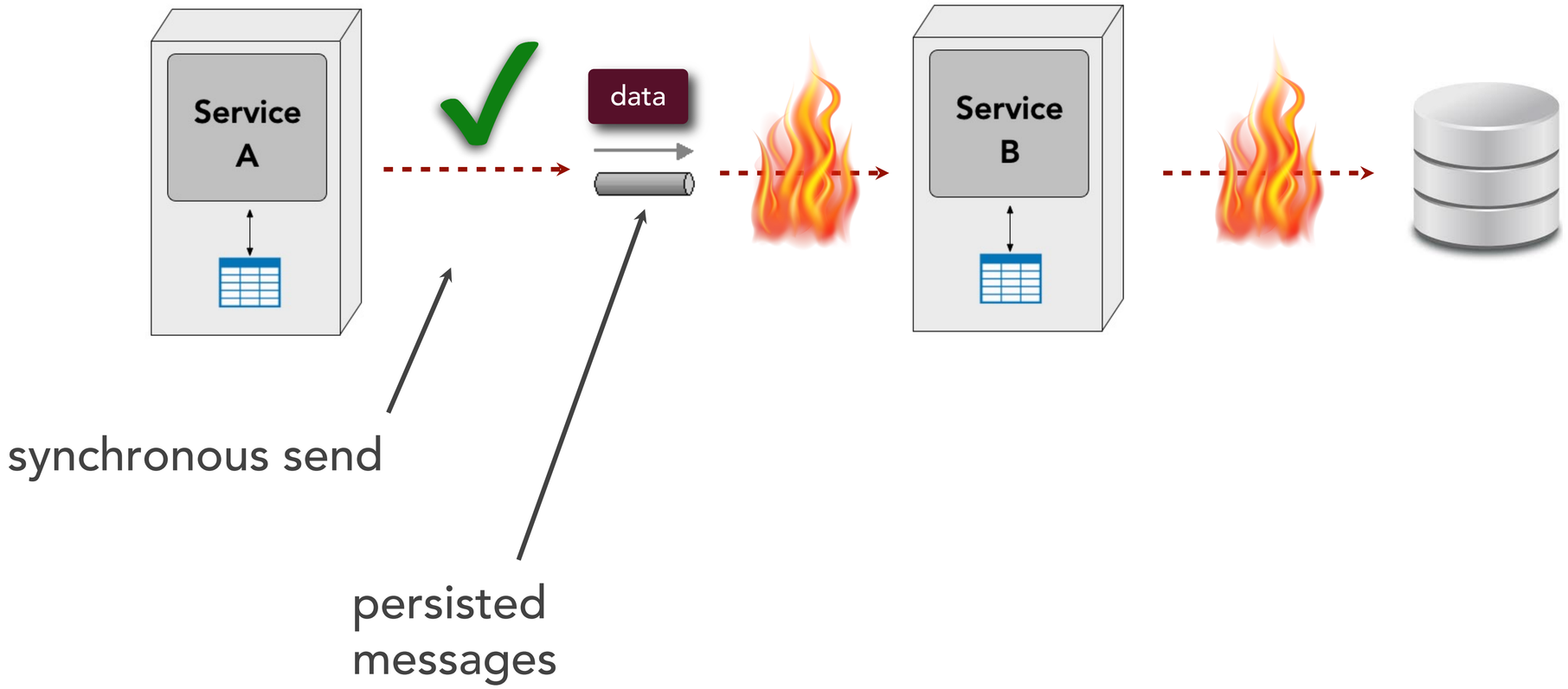

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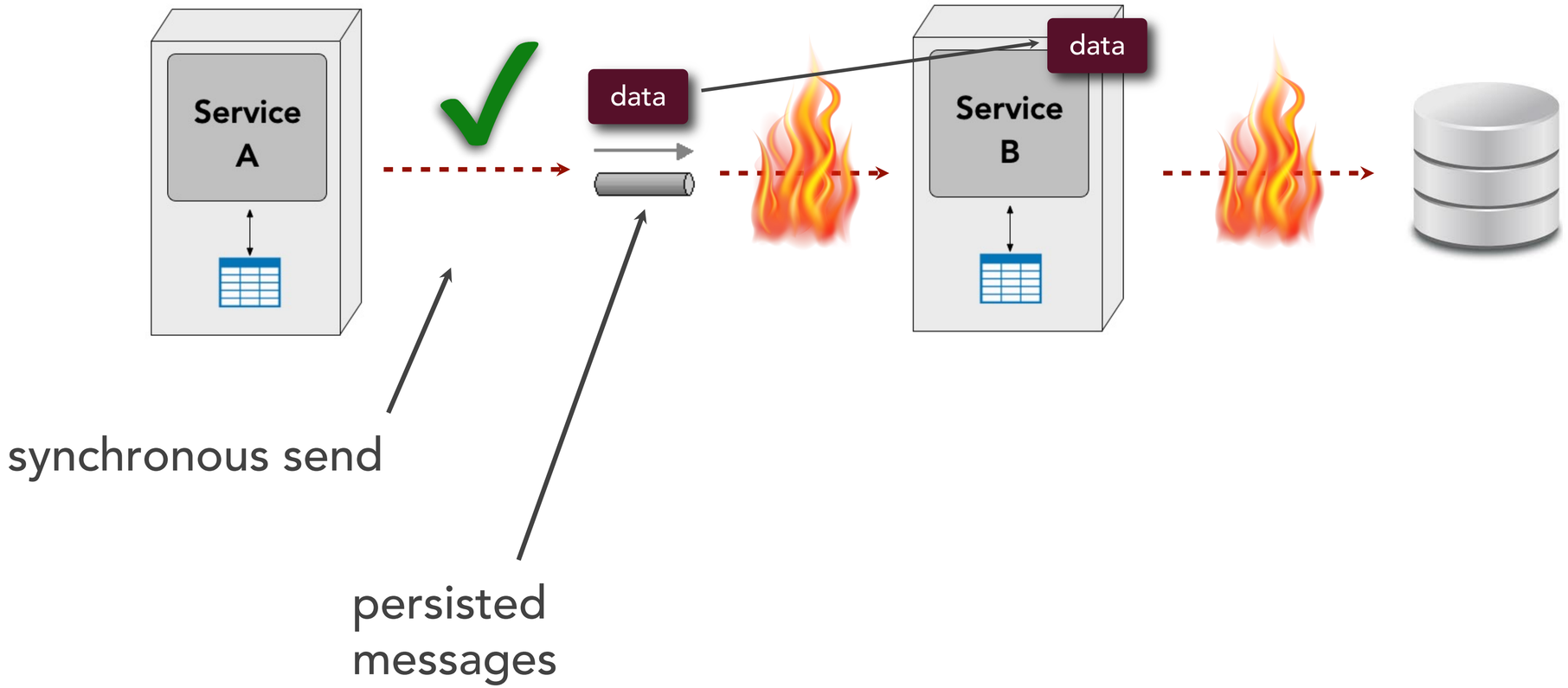

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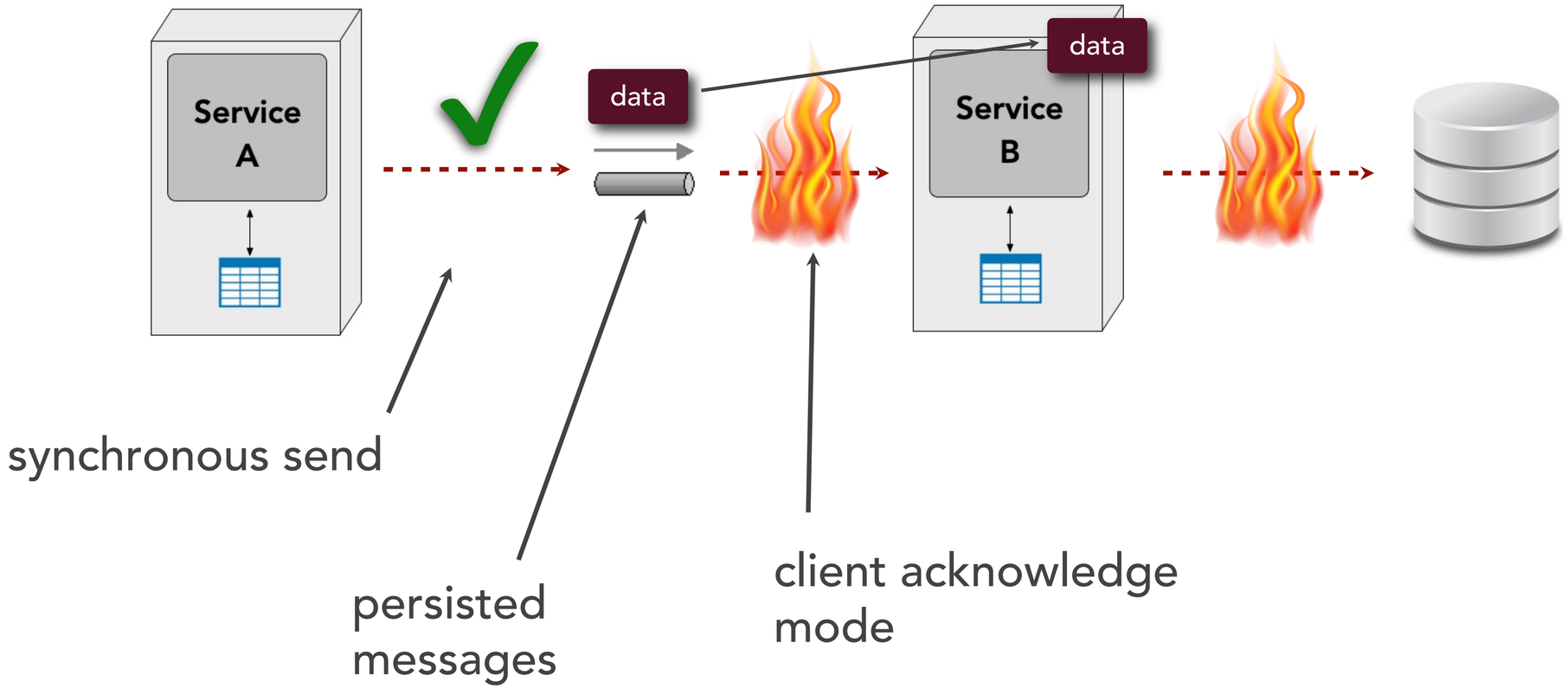

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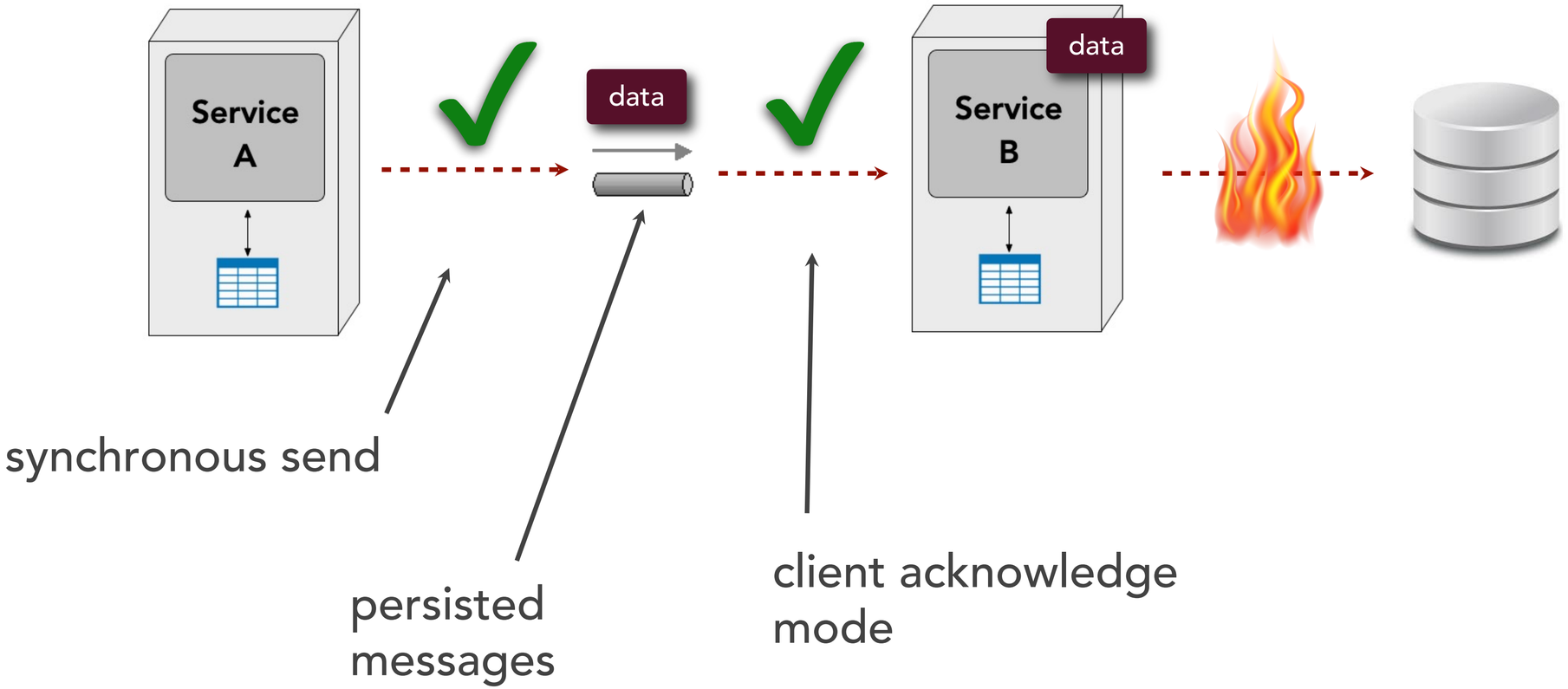

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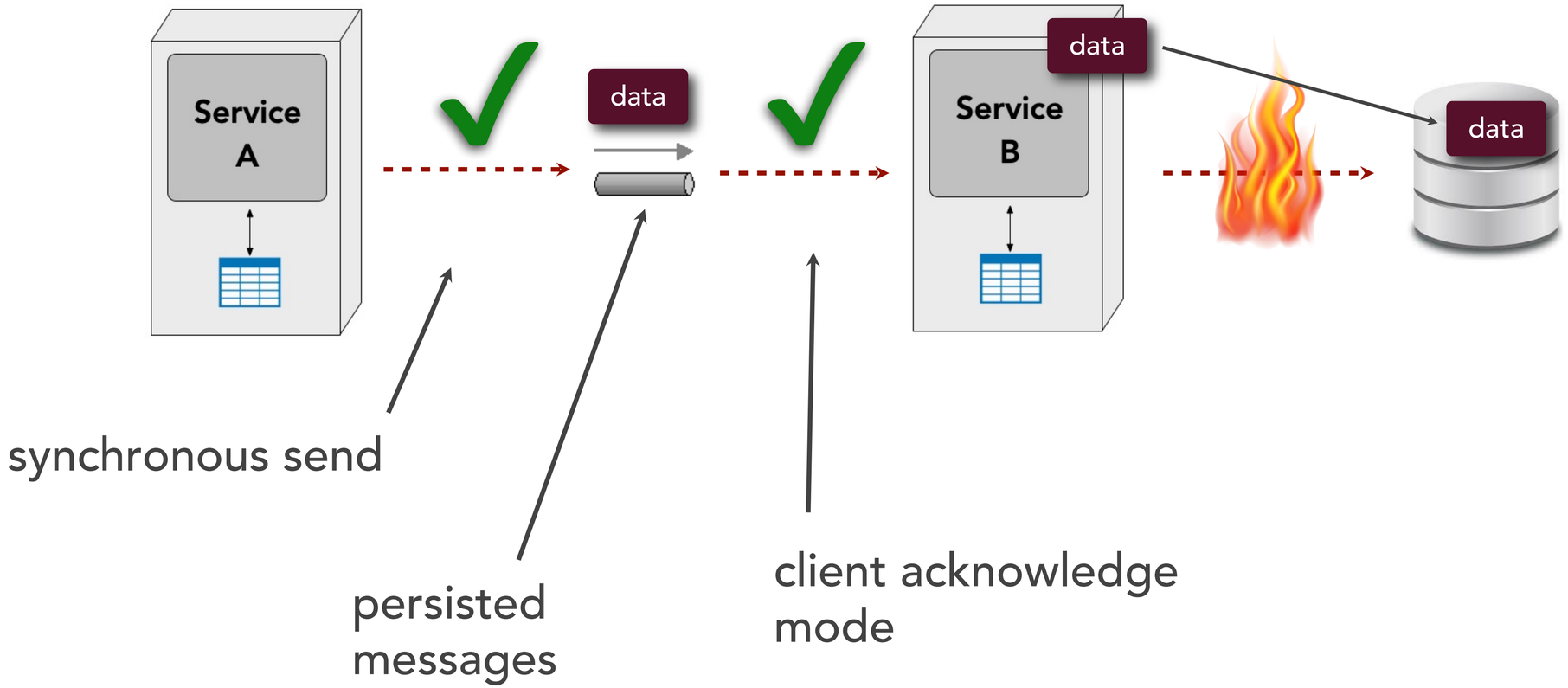

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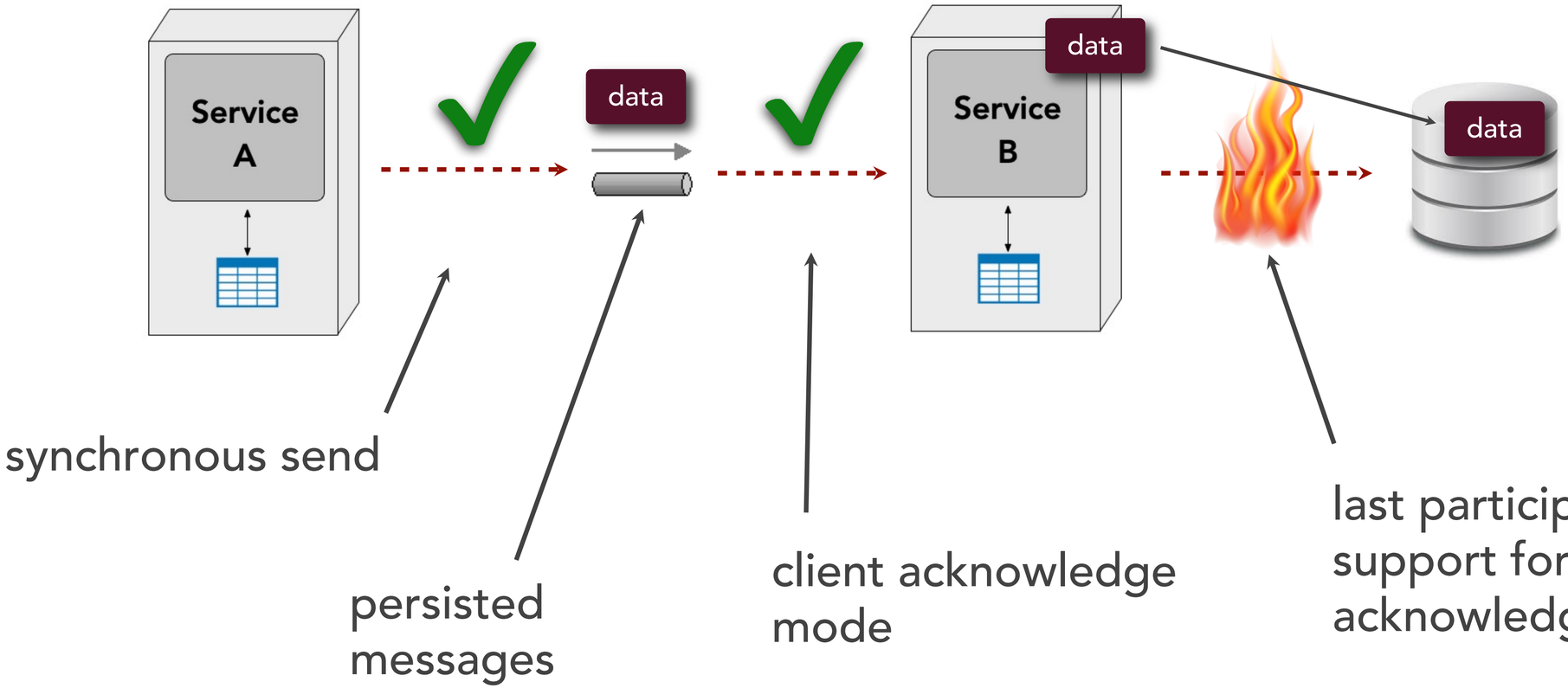

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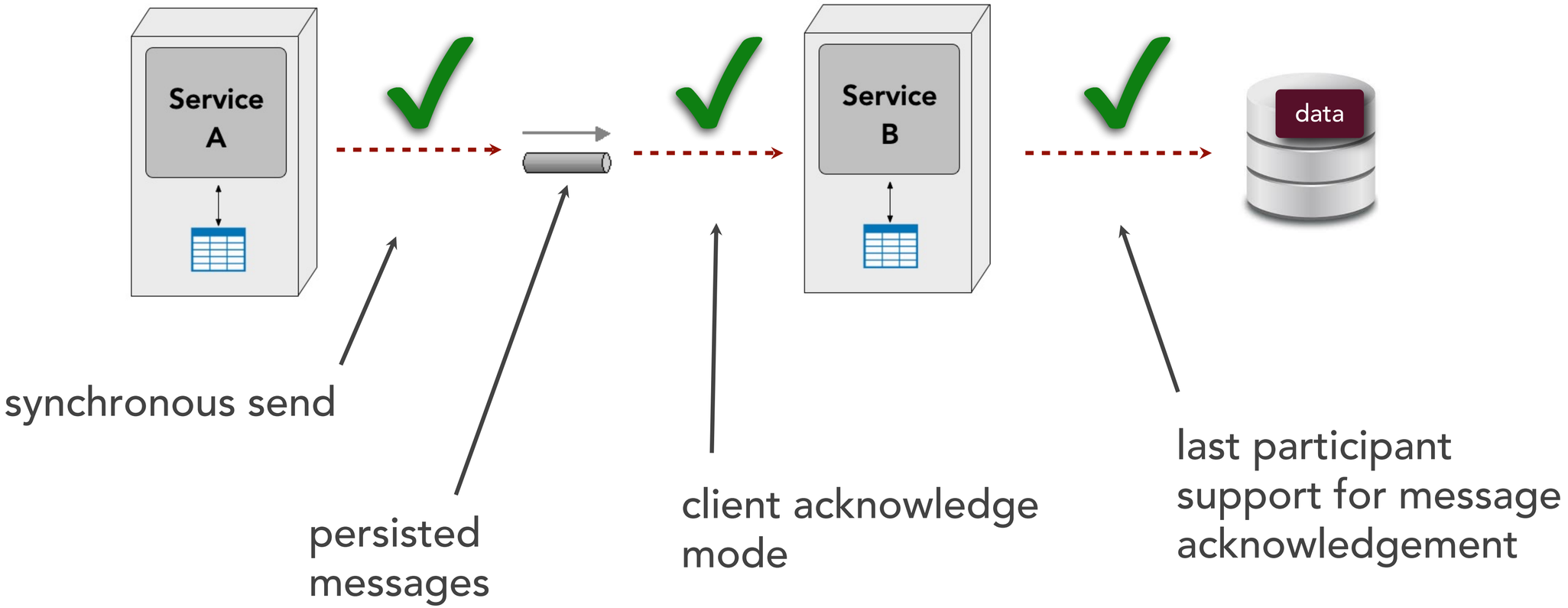

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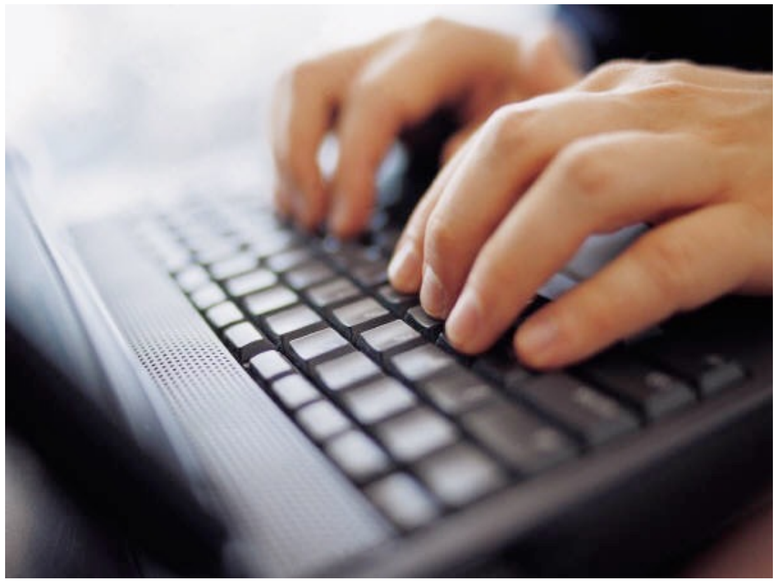
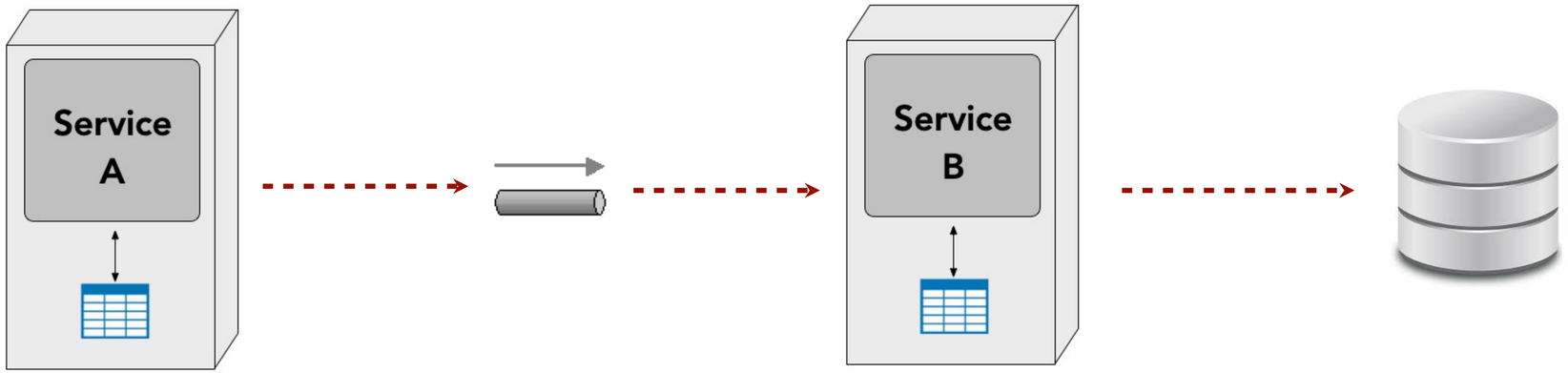
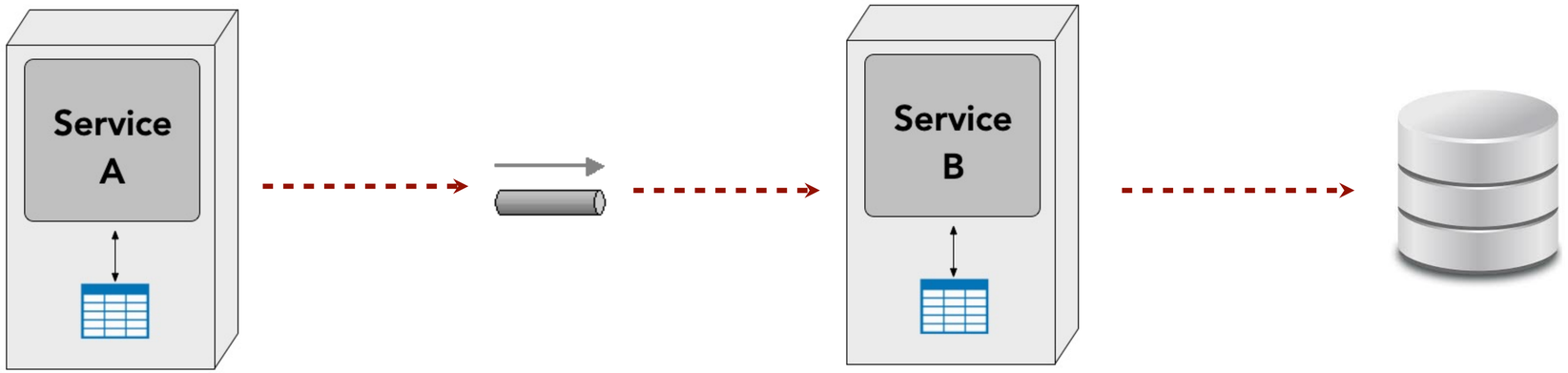


let’s apply the pattern…

event forwarding pattern



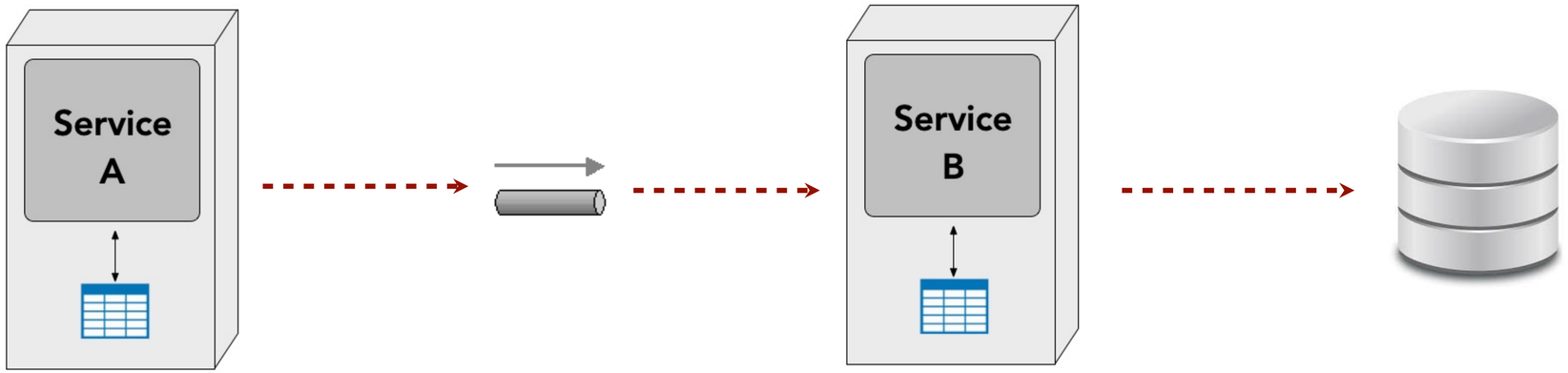
event forwarding pattern



no message loss

data integrity

event forwarding pattern



no message loss

data integrity

performance

throughput

possible duplicates

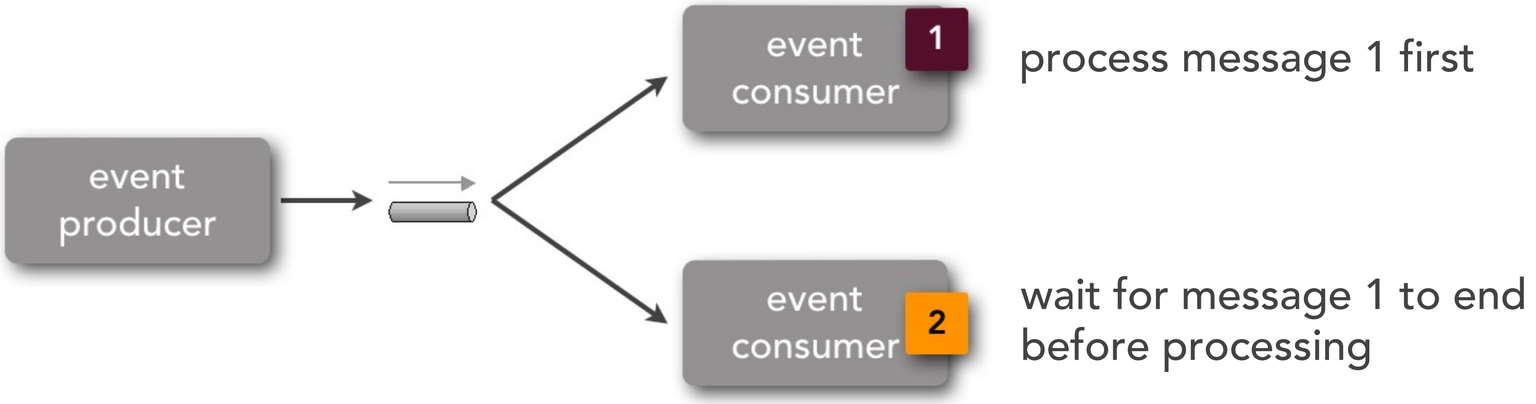
Thread Delegate Pattern

thread delegate pattern

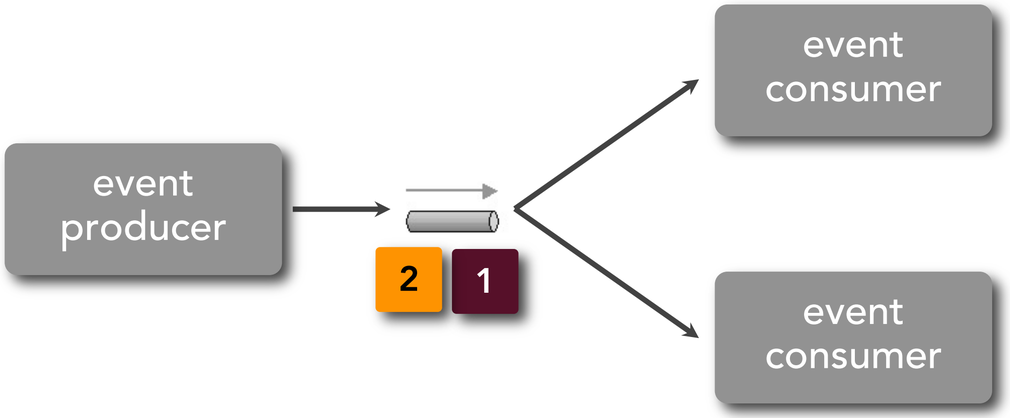
https://github.com/wmr513/reactive/tree/master/threaddelegate

thread delegate pattern

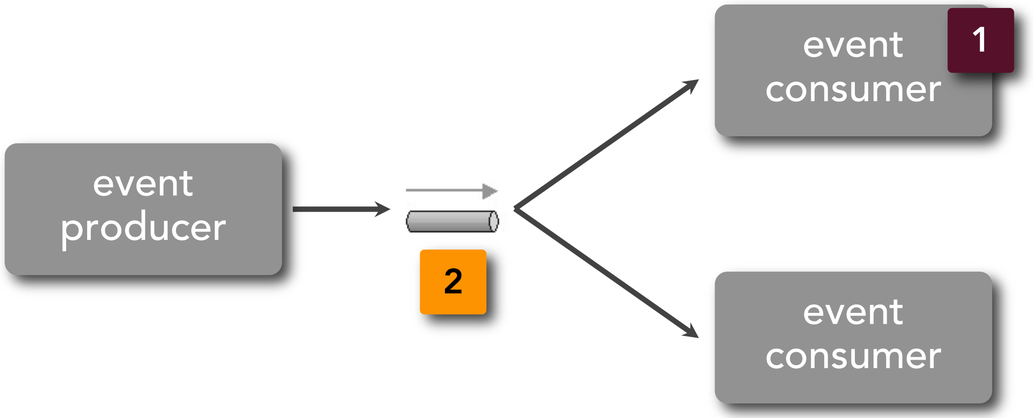
"how can I increase performance and throughput while still maintaining message processing order?"



thread delegate pattern



thread delegate pattern



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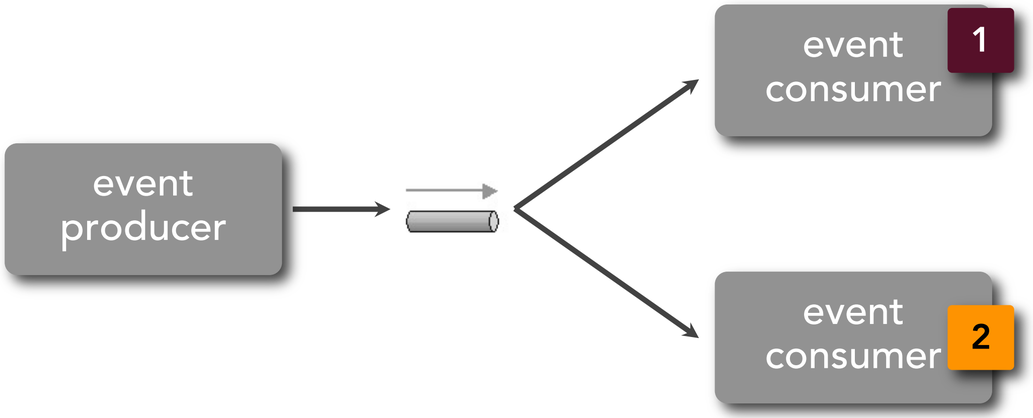

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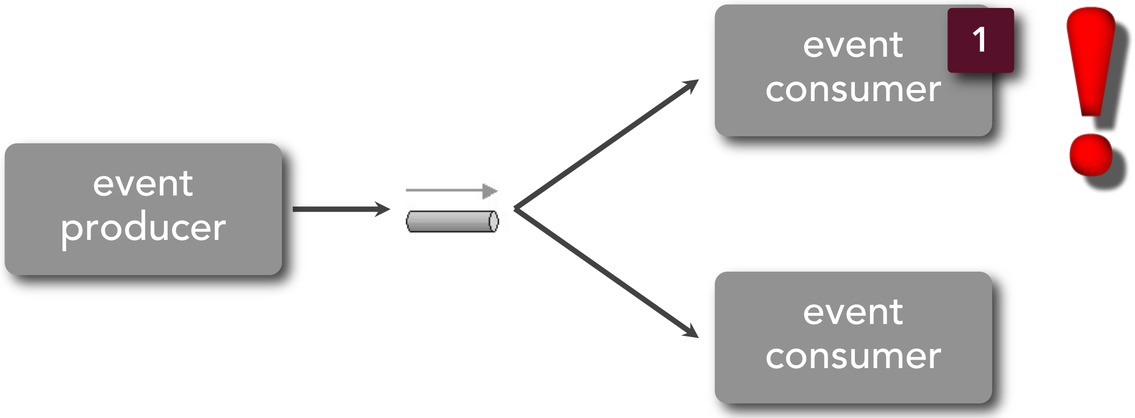

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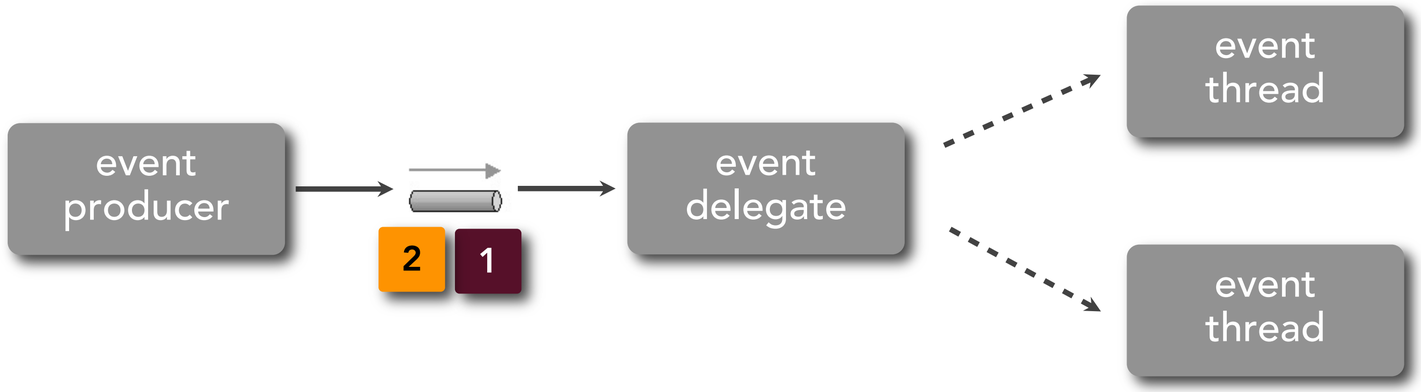
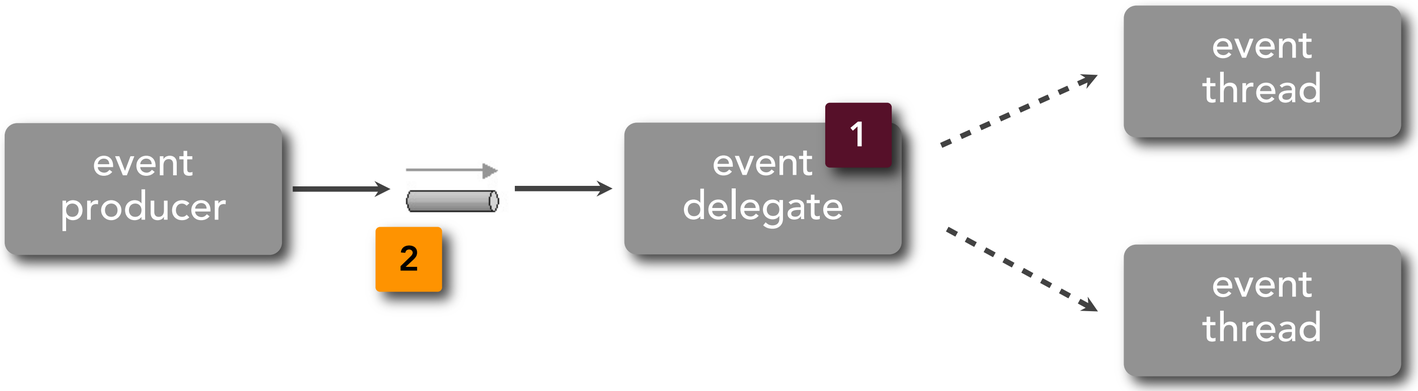


thread delegate pattern



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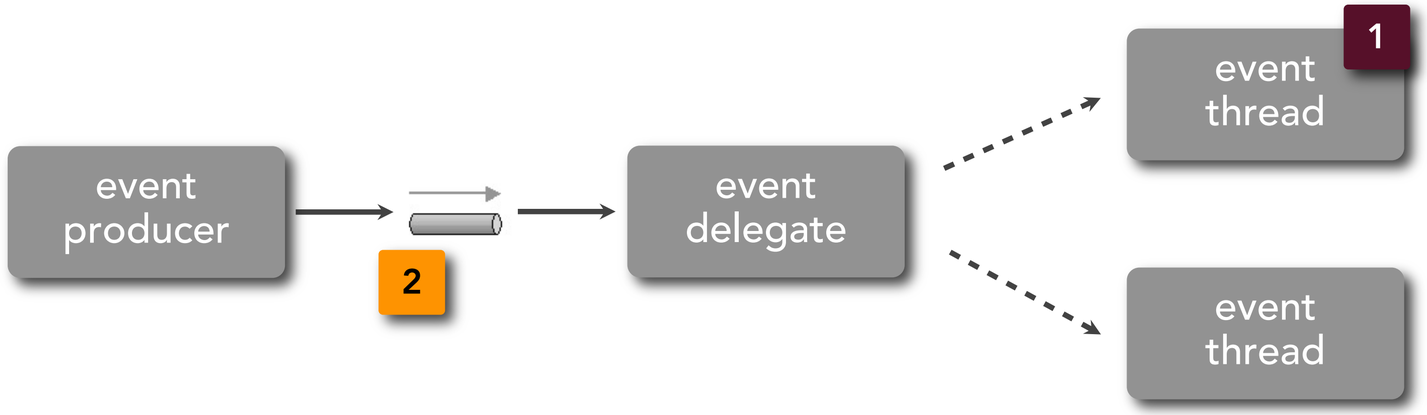

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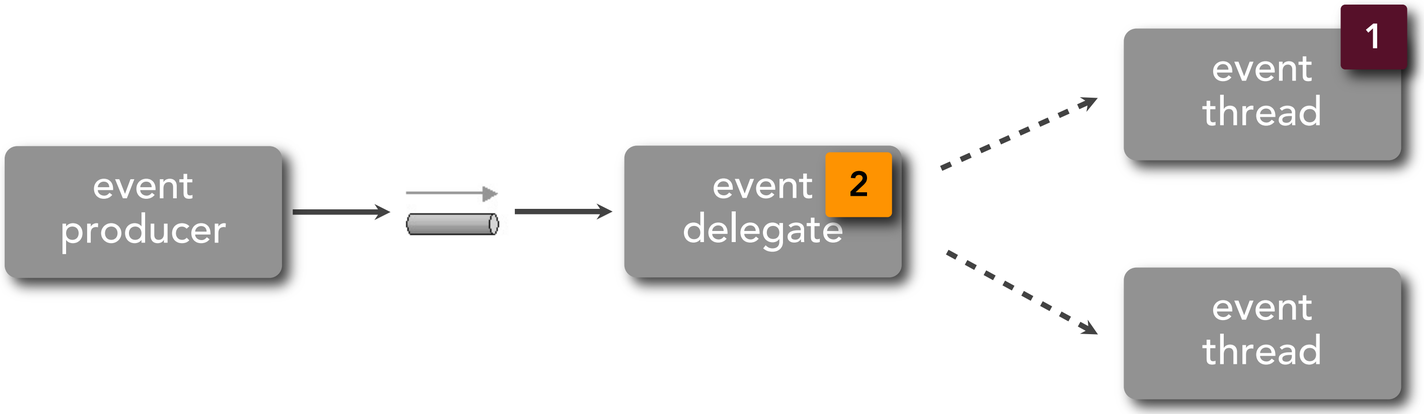

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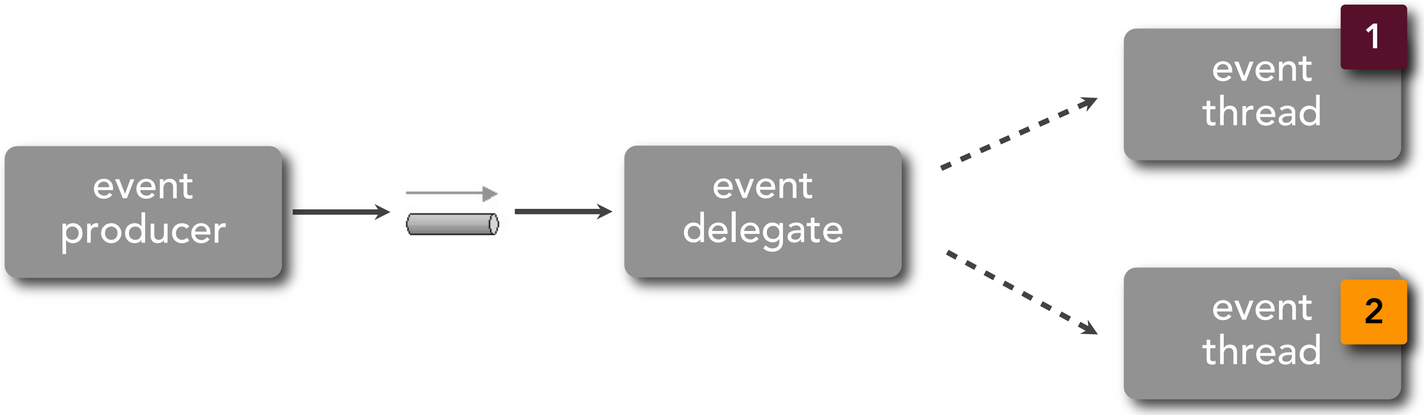

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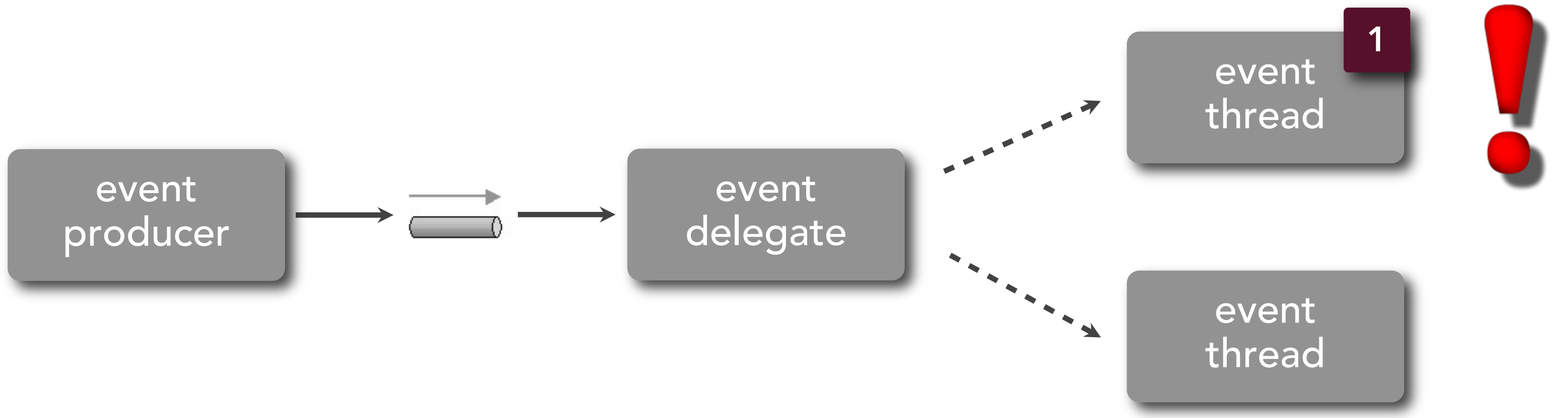
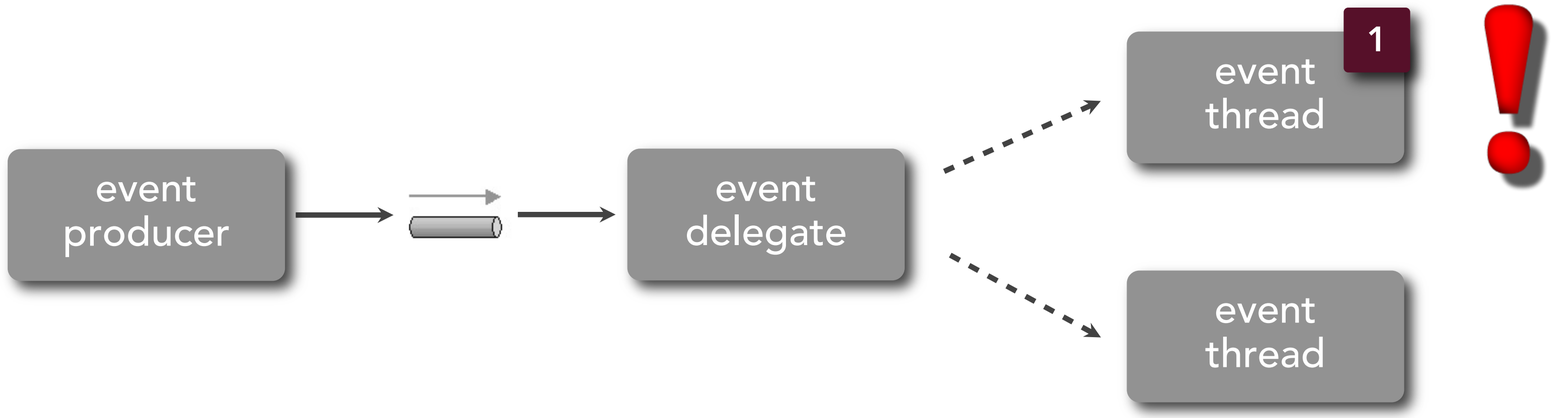


thread delegate pattern

wait - isn't this IMPOSSIBLE?



thread delegate pattern

The Art of the Impossible

https://www.youtube.com/watch?v=Z4LRexqmnik

(15:10 - 21:40)

thread delegate pattern

not every message must be ordered, but rather messages
within a specific context must be ordered

thread delegate pattern

not every message must be ordered, but rather messages
within a specific context must be ordered

```
1. PLACE  SELL GOOG A-136 2,000,000.00
2. PLACE  BUY  AAPL A-136 1,200,000.00
3. CANCEL BUY  AAPL A-136 1,200,000.00
```

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```
1. PLACE  SELL GOOG A-136 2,000,000.00
2. PLACE  BUY  AAPL A-136 1,200,000.00
3. CANCEL BUY  AAPL A-136 1,200,000.00
```

1, 2, 3

thread delegate pattern

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```
1. PLACE  SELL GOOG A-136 2,000,000.00
2. PLACE  BUY  AAPL A-136 1,200,000.00
3. CANCEL BUY  AAPL A-136 1,200,000.00
```

1, 2, 3

```
1. PLACE  SELL AAPL A-136 2,000,000.00
2. PLACE  SELL GOOG V-976   650,000.00
3. PLACE  BUY  ATT  V-976   900,000.00
4. PLACE  BUY  IBM  A-136 1,300,000.00
5. CANCEL BUY  ATT  V-976   900,000.00
```

thread delegate pattern

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within a specific context must be ordered

```
1. PLACE  SELL GOOG A-136 2,000,000.00
2. PLACE  BUY  AAPL A-136 1,200,000.00
3. CANCEL BUY  AAPL A-136 1,200,000.00
```

1, 2, 3

```
1. PLACE  SELL AAPL A-136 2,000,000.00
2. PLACE  SELL GOOG V-976   650,000.00
3. PLACE  BUY  ATT  V-976   900,000.00
4. PLACE  BUY  IBM  A-136 1,300,000.00
5. CANCEL BUY  ATT  V-976   900,000.00
```

1, 4

thread delegate pattern

not every message must be ordered, but rather messages
within a specific context must be ordered

```
1. PLACE  SELL GOOG A-136 2,000,000.00
2. PLACE  BUY  AAPL A-136 1,200,000.00
3. CANCEL BUY  AAPL A-136 1,200,000.00
```

1, 2, 3

```
1. PLACE  SELL AAPL A-136 2,000,000.00
2. PLACE  SELL GOOG V-976   650,000.00
3. PLACE  BUY  ATT  V-976   900,000.00
4. PLACE  BUY  IBM  A-136 1,300,000.00
5. CANCEL BUY  ATT  V-976   900,000.00
```

2, 3, 5

thread delegate pattern

not every message must be ordered, but rather messages
within a specific context must be ordered

```
1. PLACE  SELL GOOG A-136 2,000,000.00
2. PLACE  BUY  AAPL A-136 1,200,000.00
3. CANCEL BUY  AAPL A-136 1,200,000.00
```

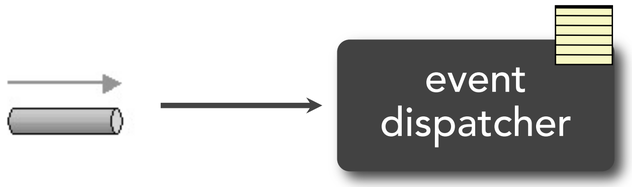
1, 2, 3

```
1. PLACE  SELL AAPL A-136 2,000,000.00
2. PLACE  SELL GOOG V-976   650,000.00
3. PLACE  BUY  ATT  V-976   900,000.00
4. PLACE  BUY  IBM  A-136 1,300,000.00
5. CANCEL BUY  ATT  V-976   900,000.00
```

1, 4

2, 3, 5

thread delegate pattern



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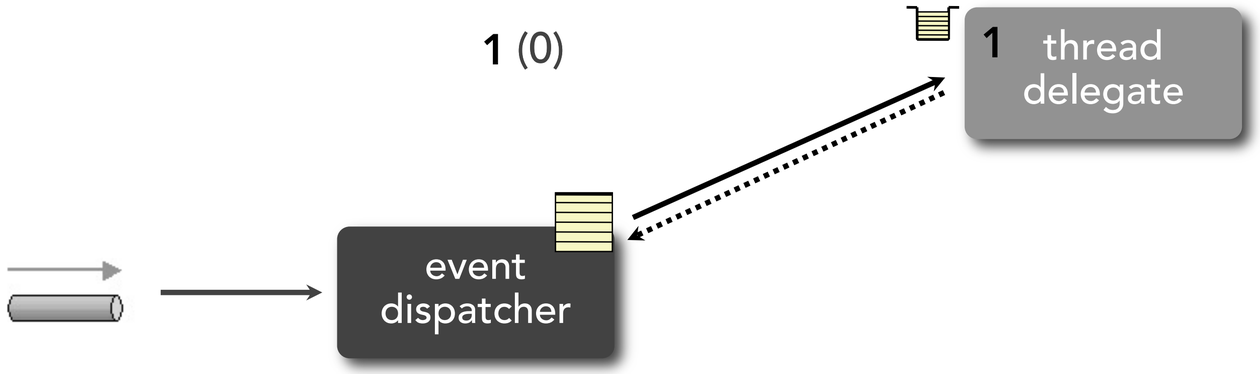

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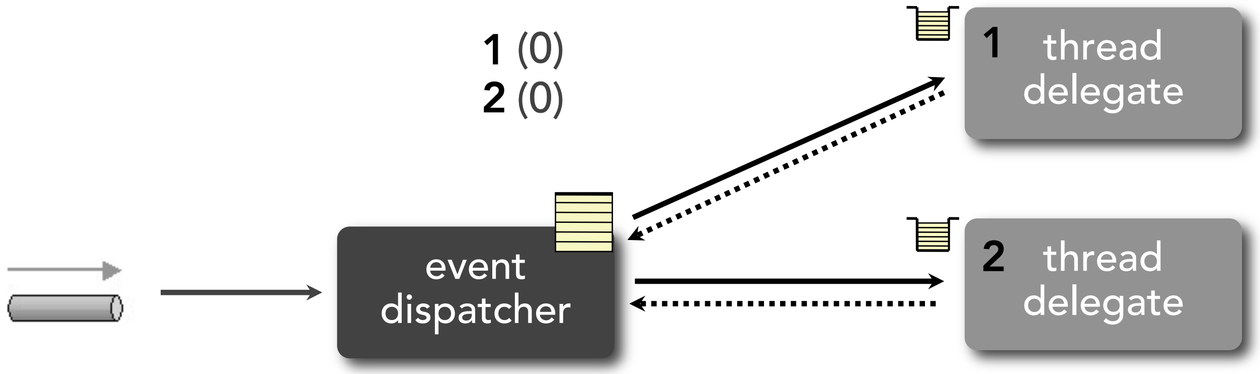

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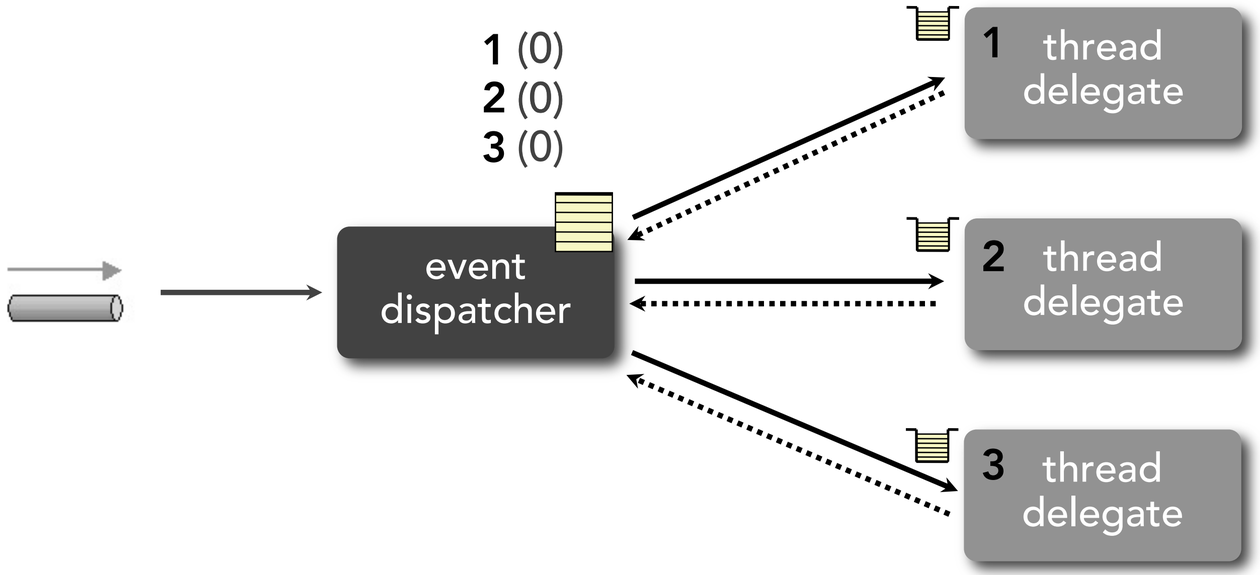
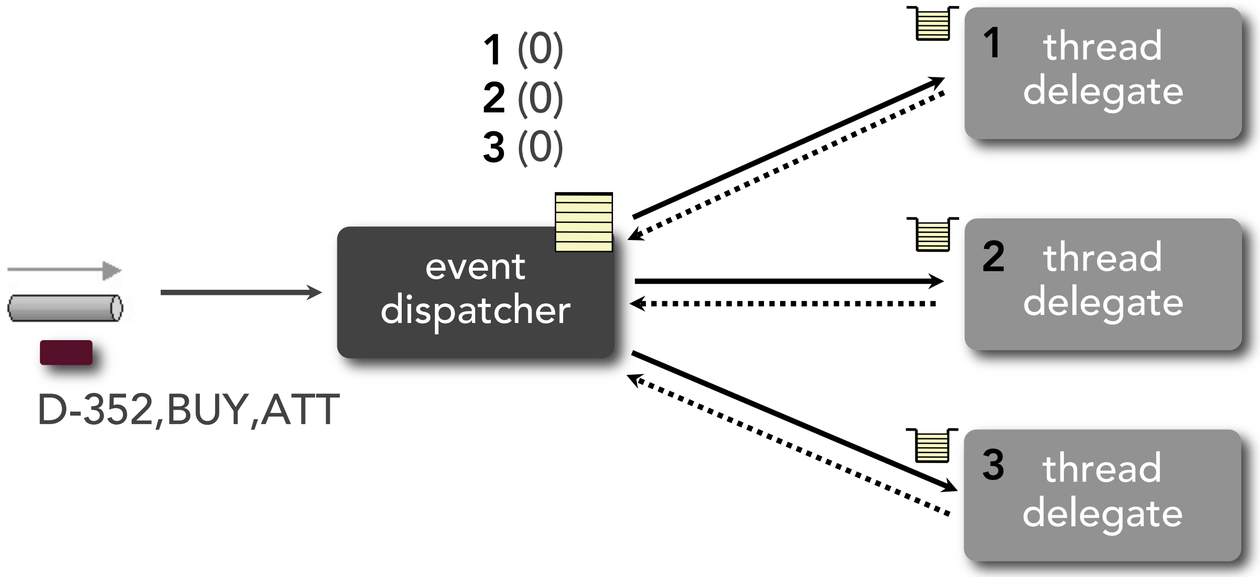


thread delegate pattern



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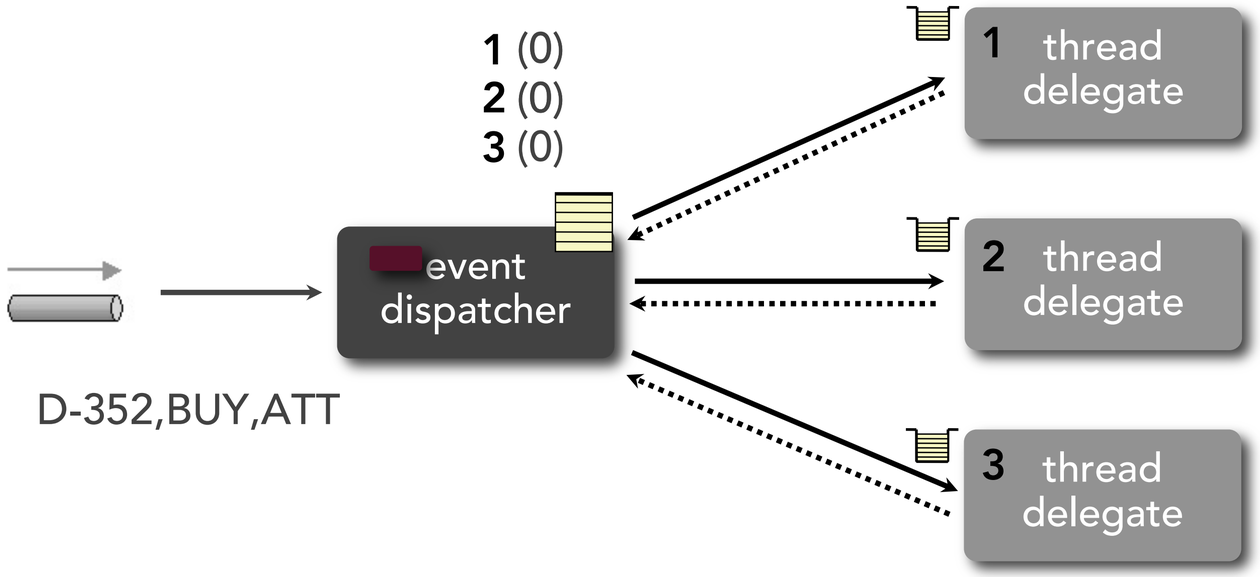

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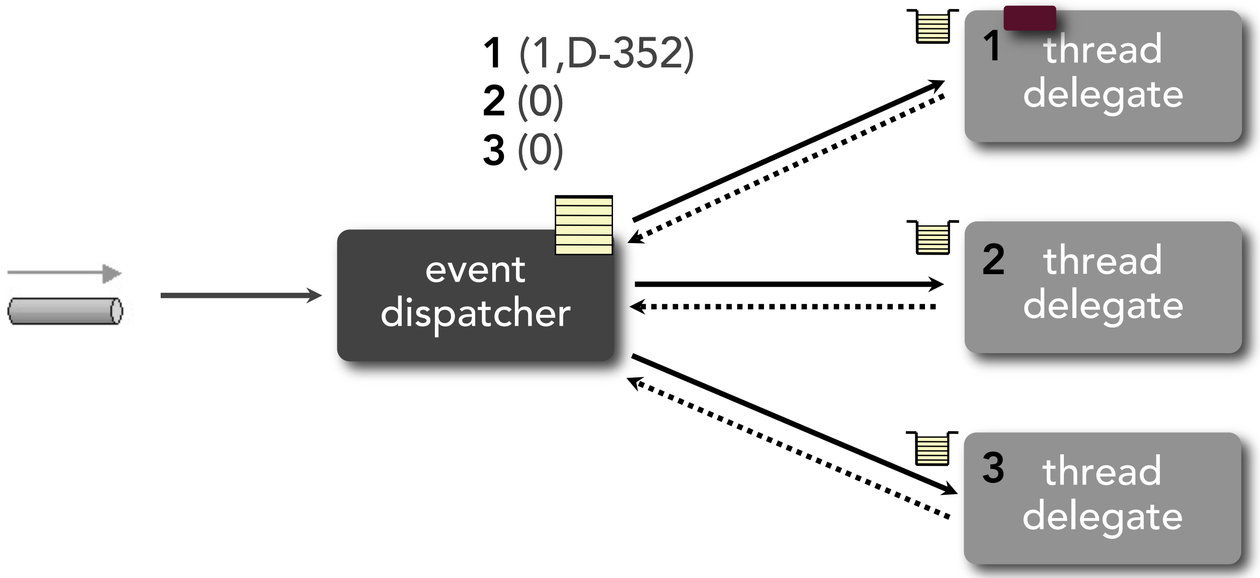

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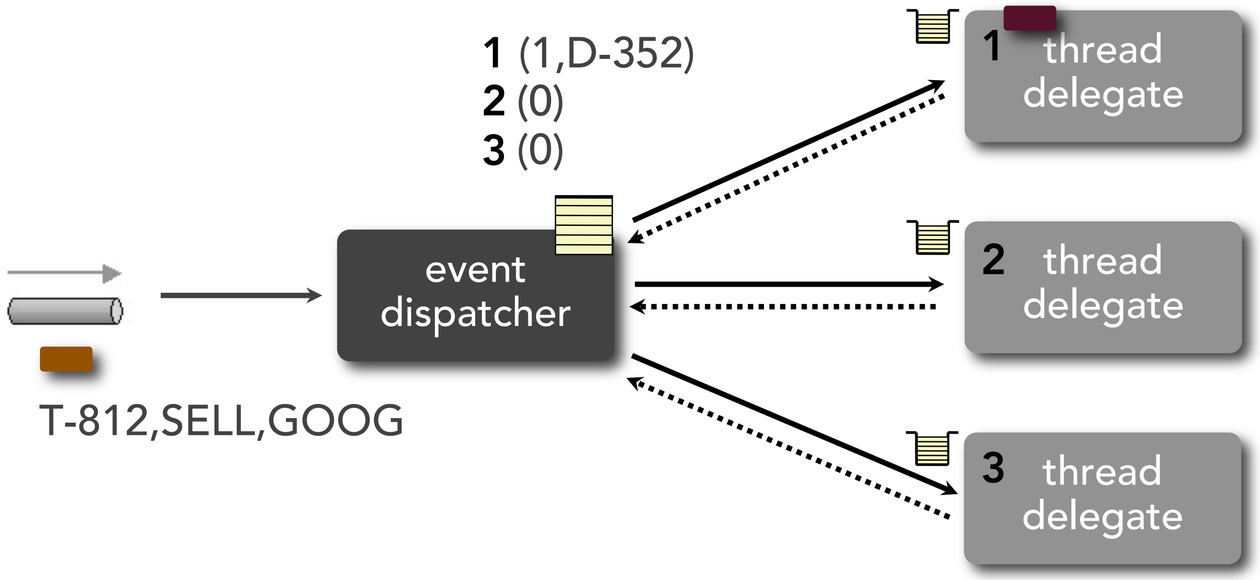

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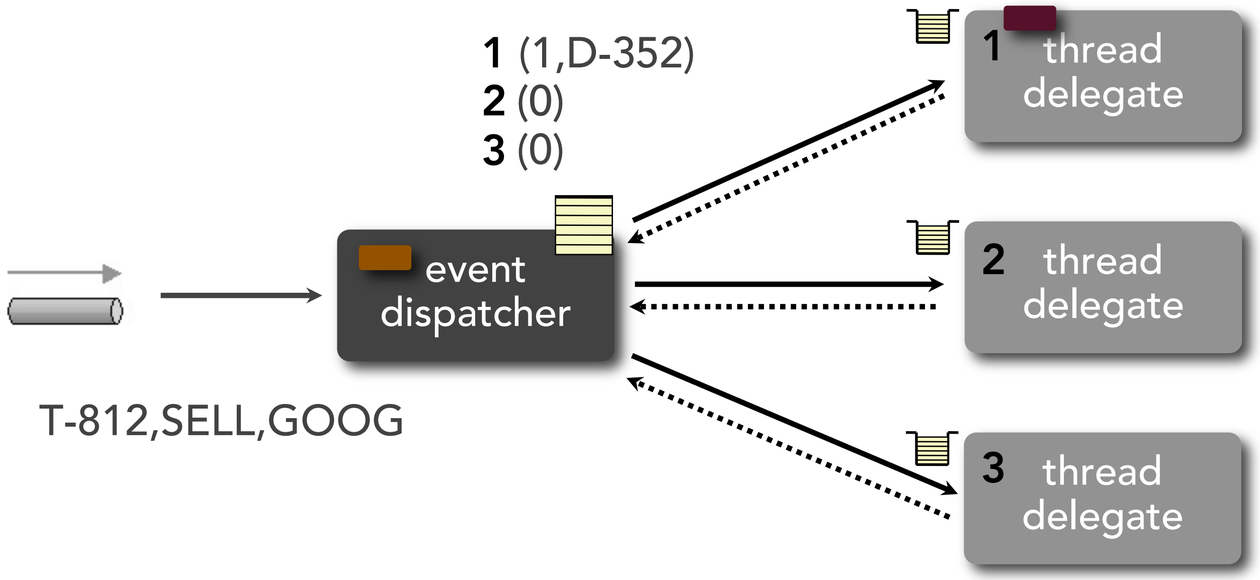

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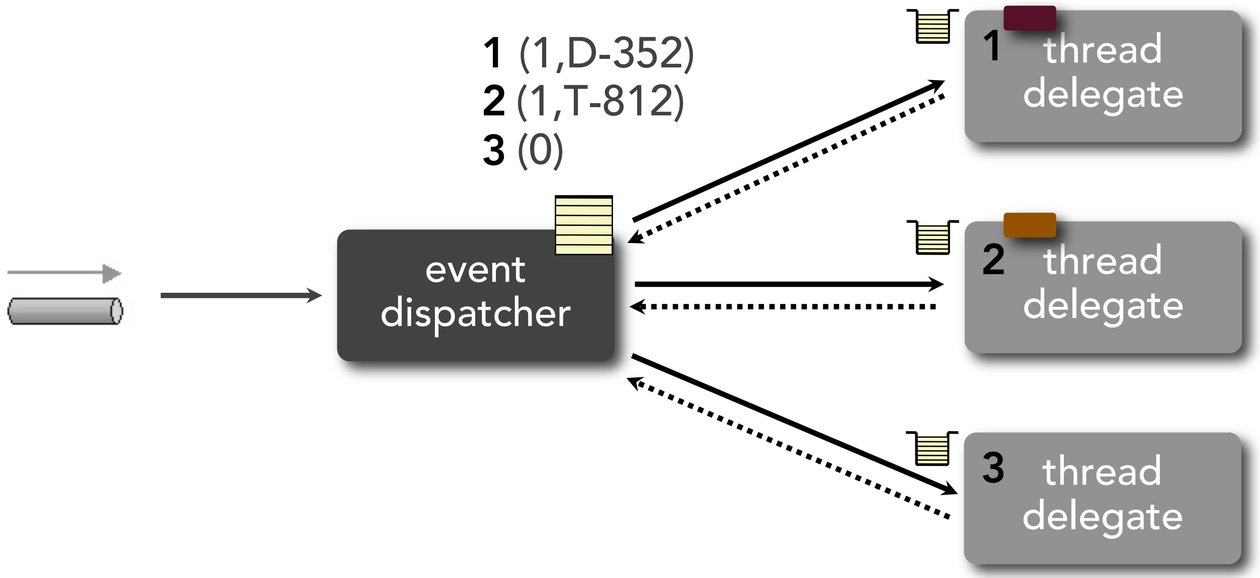

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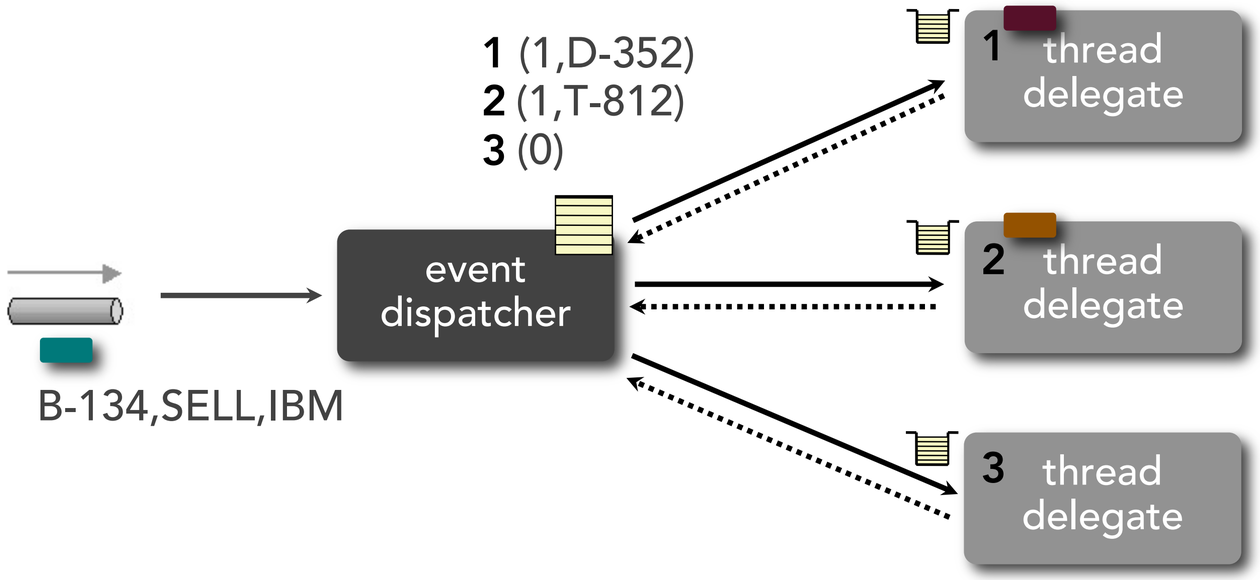

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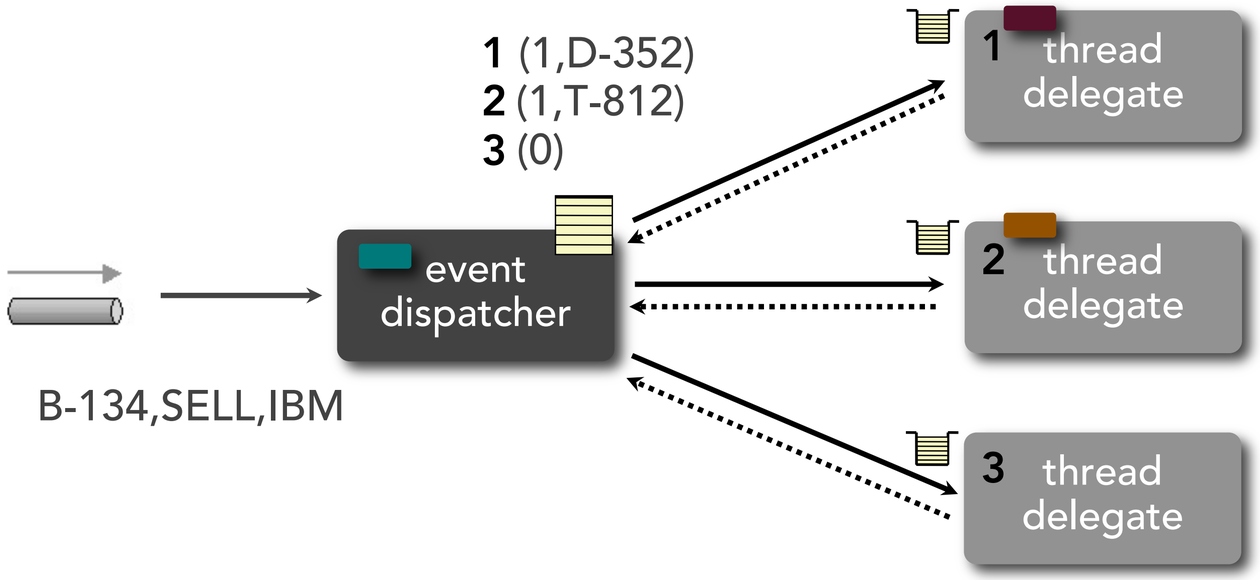
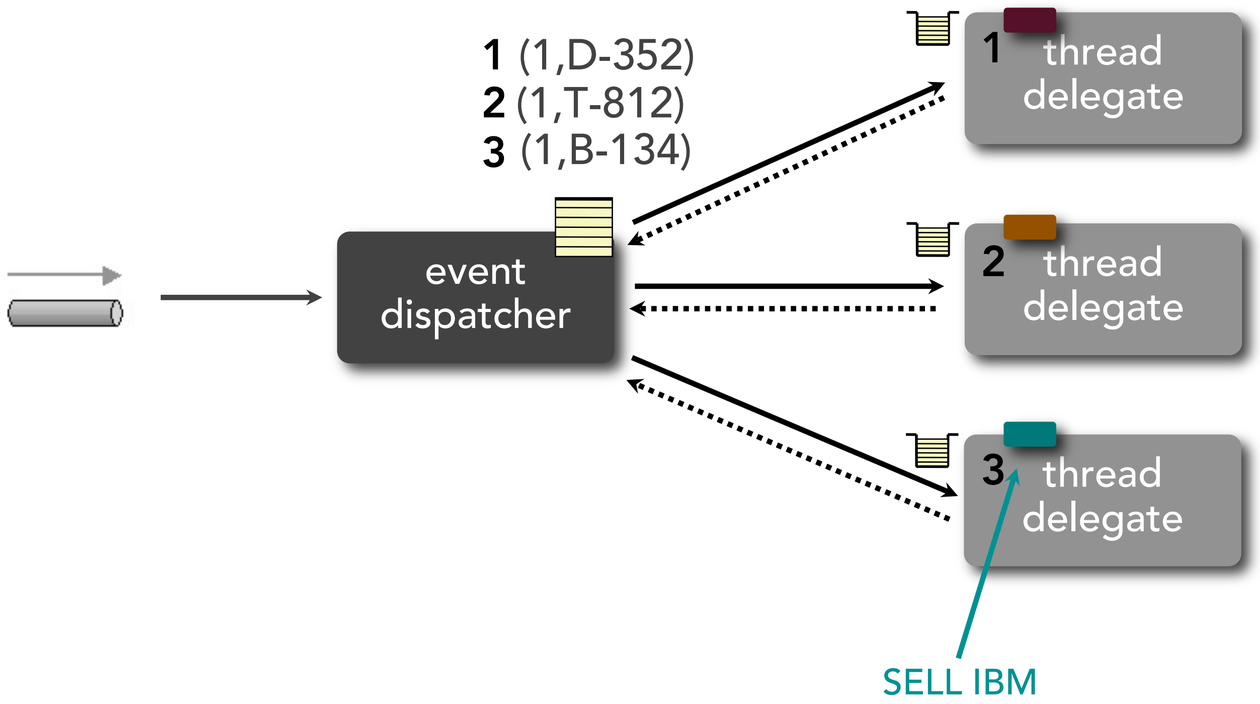


thread delegate pattern



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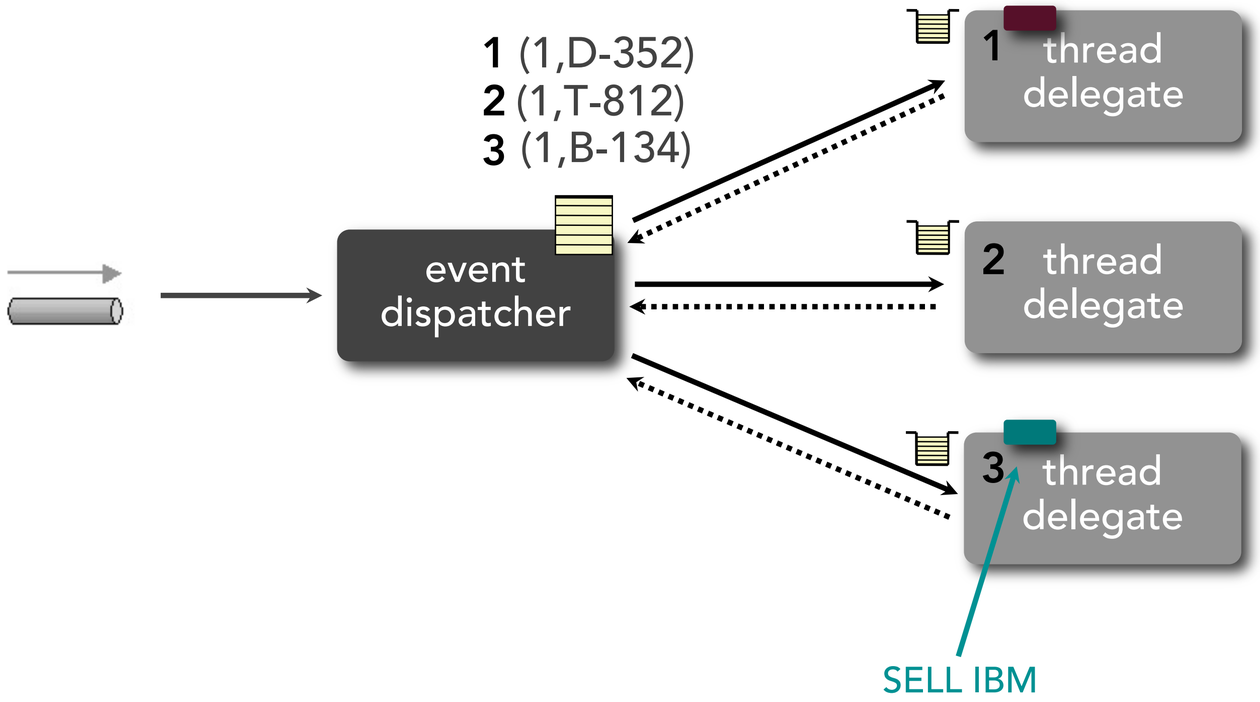

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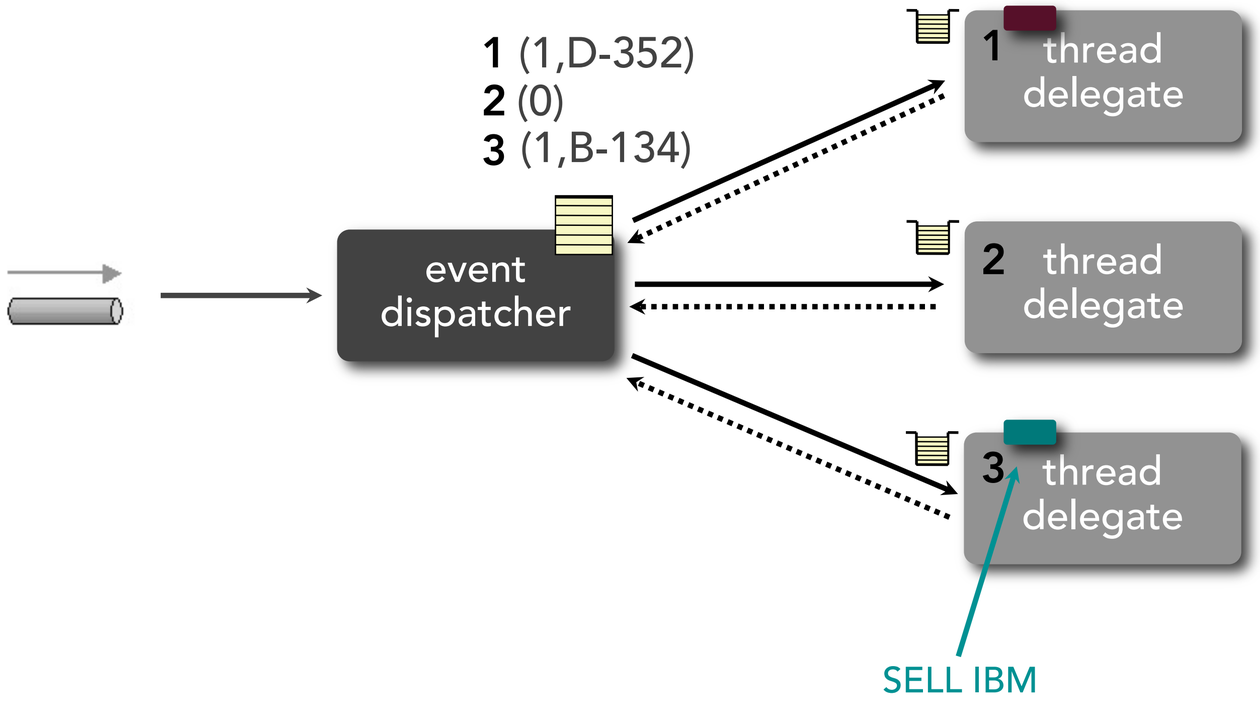

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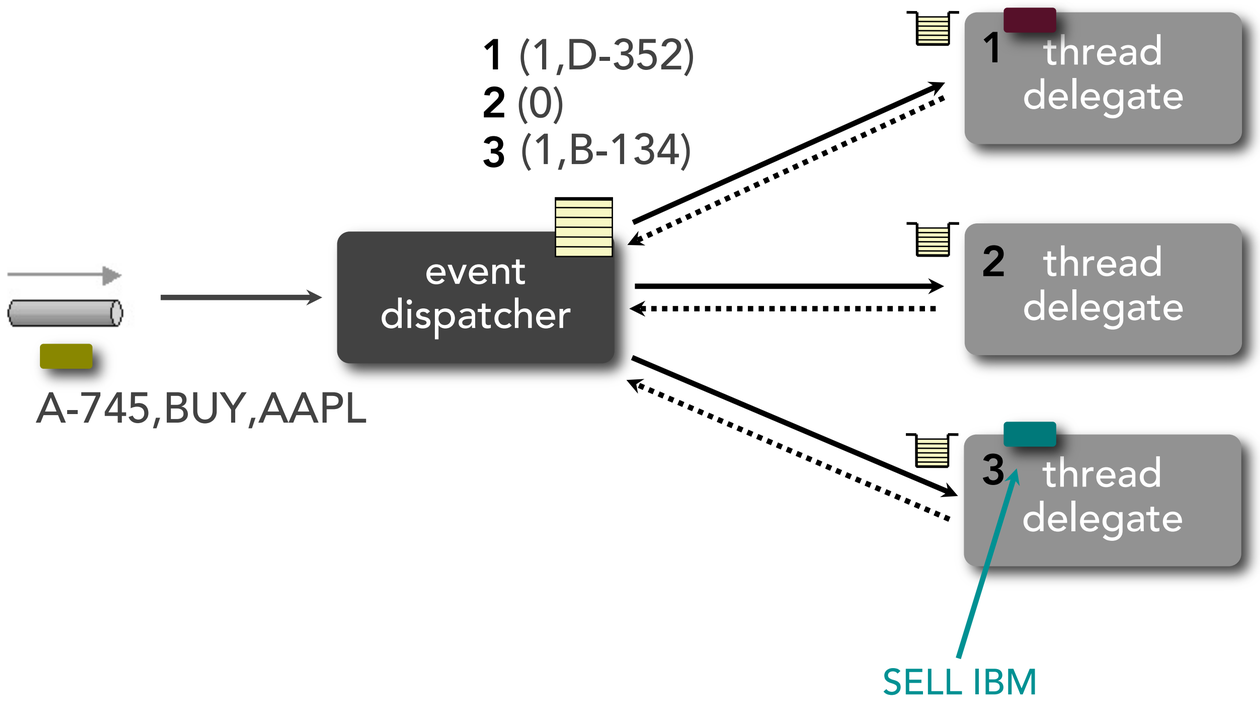

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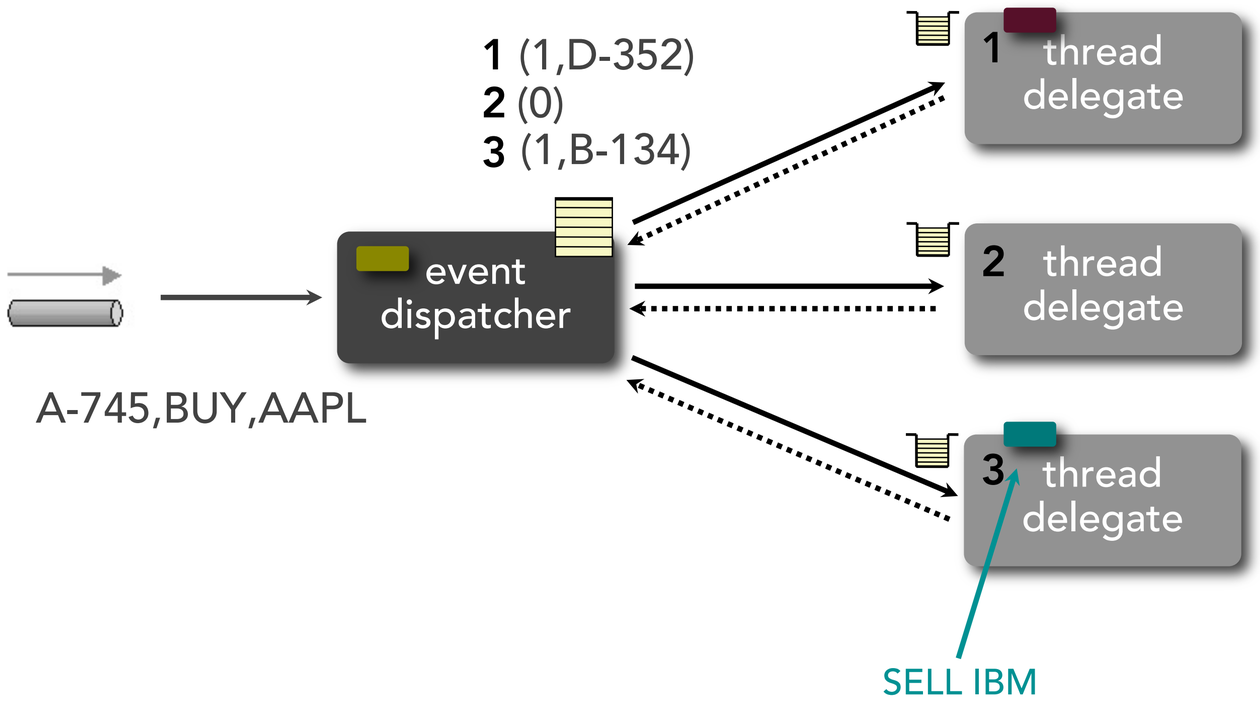

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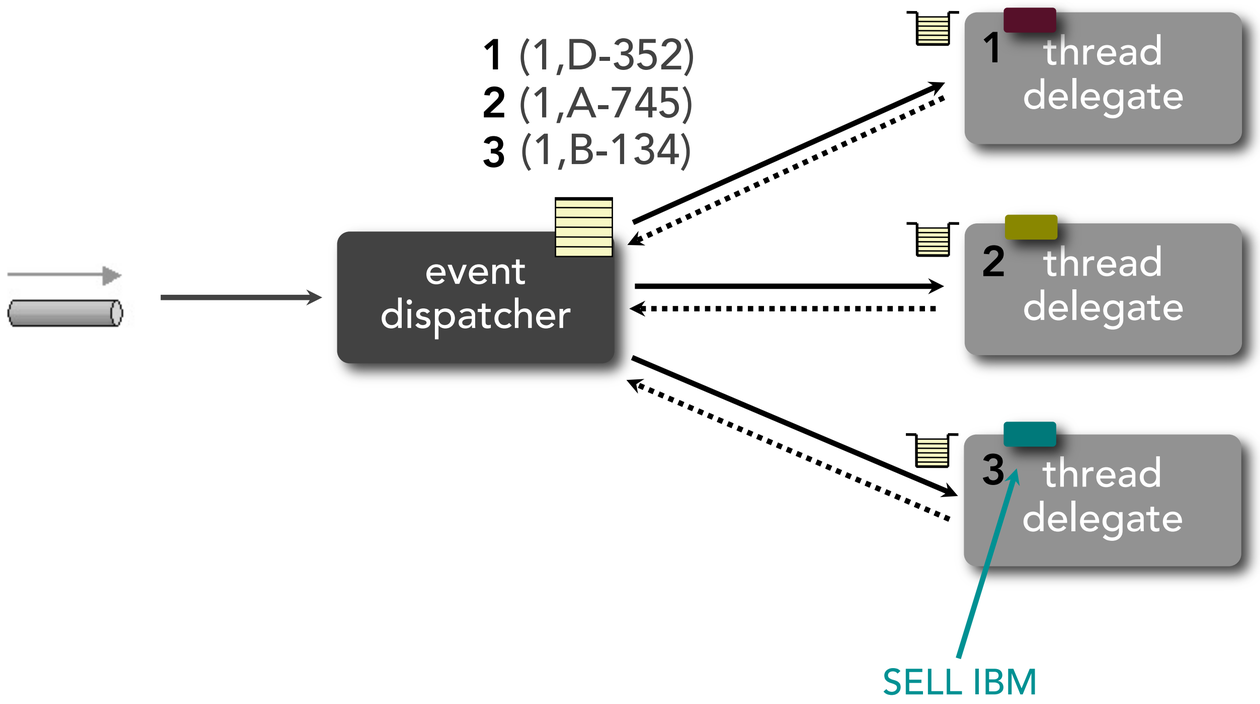

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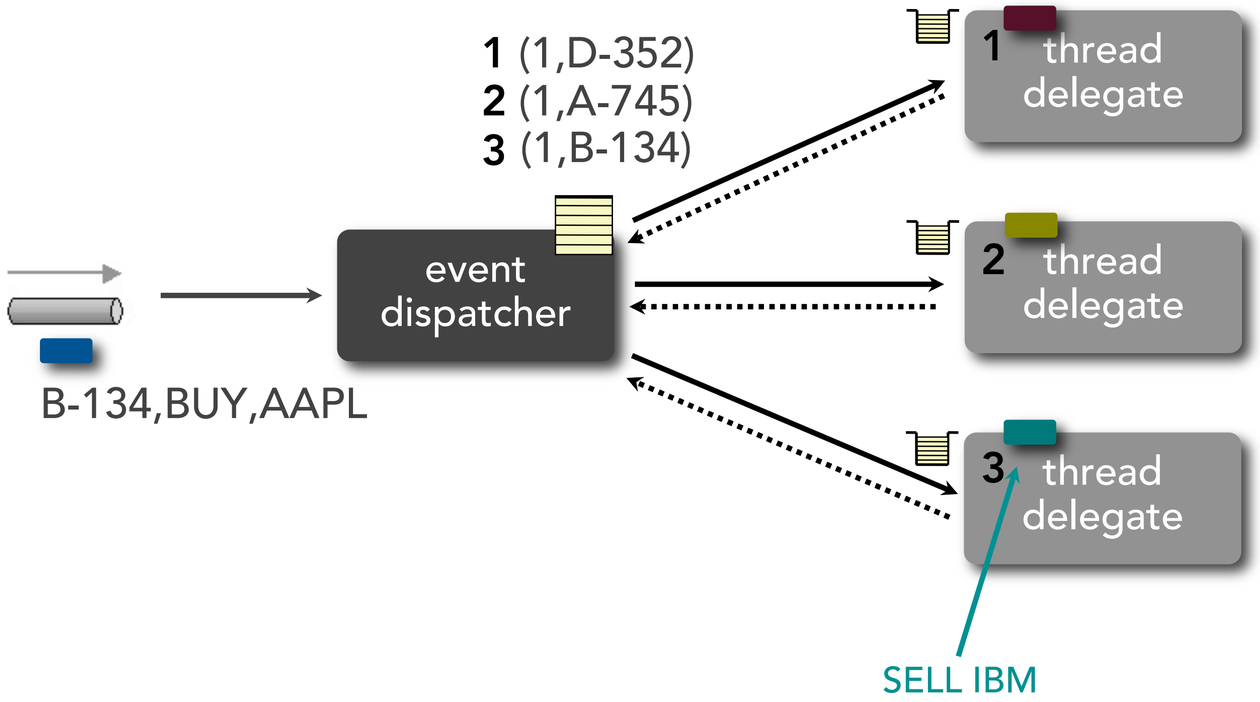

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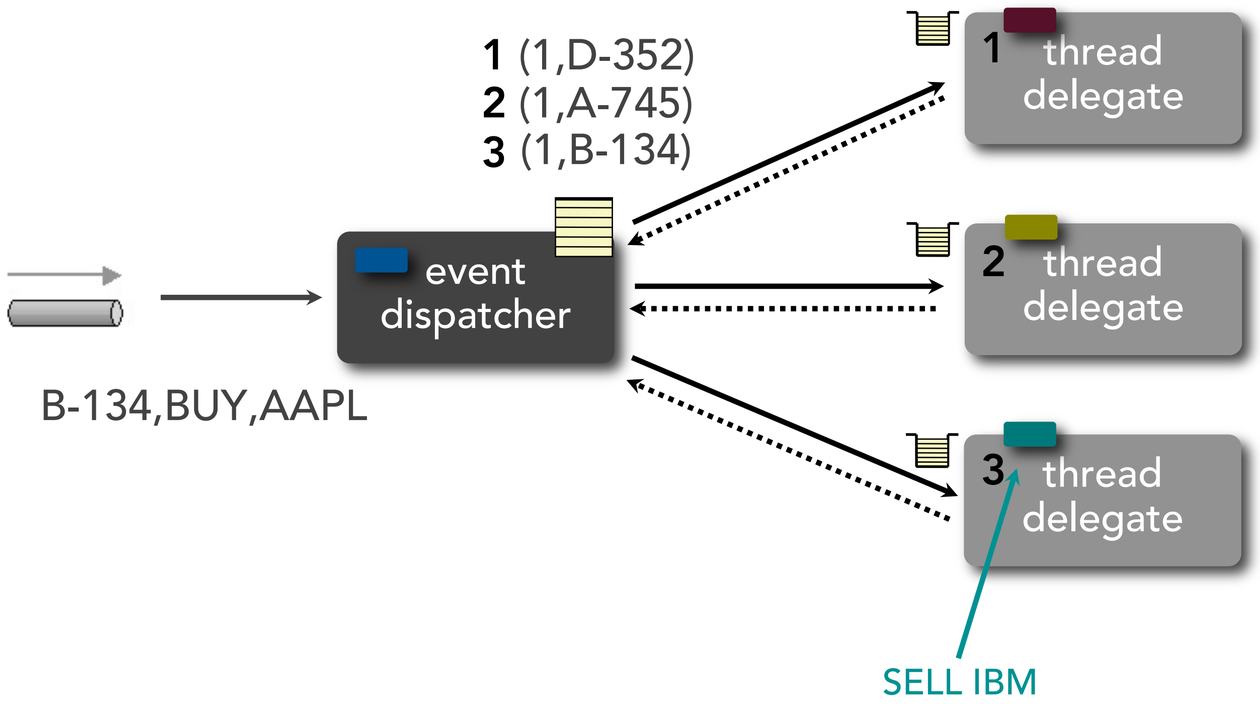

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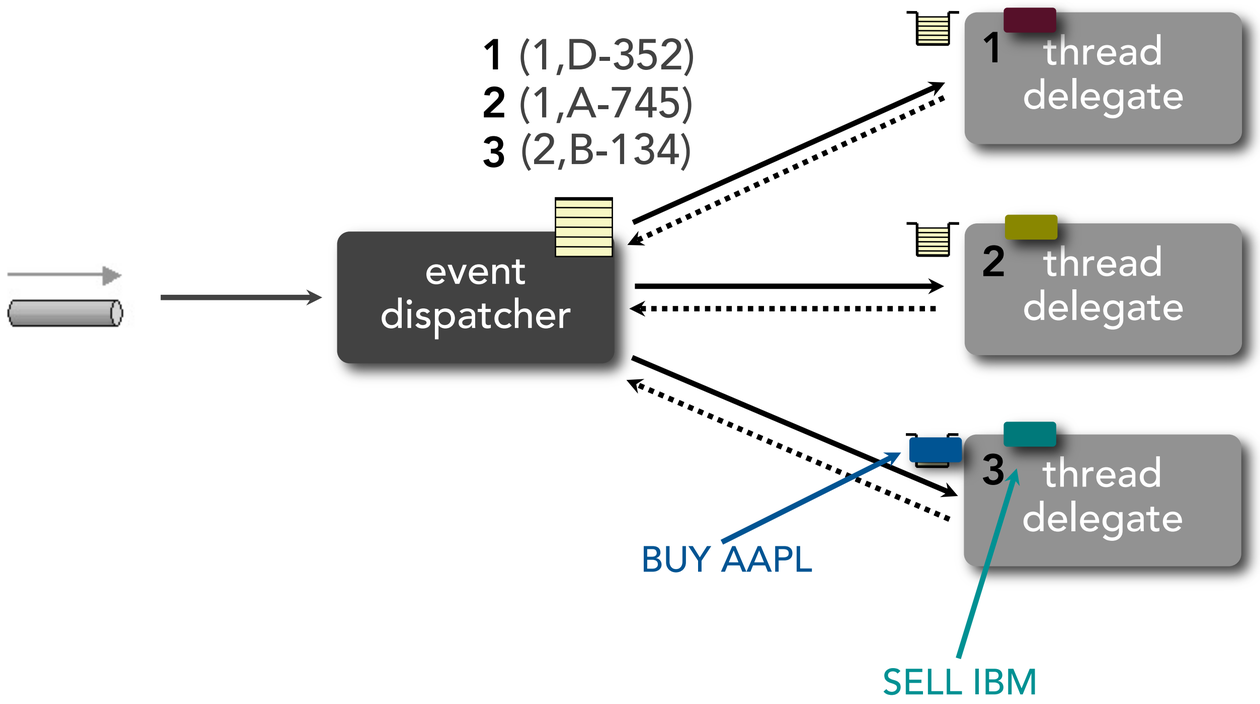

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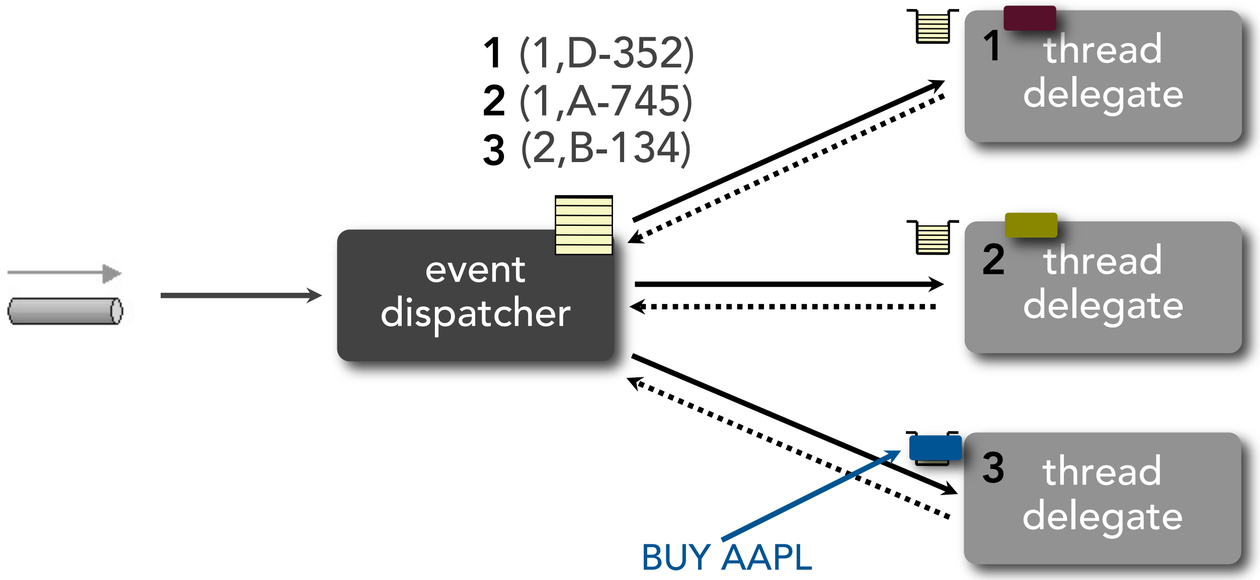

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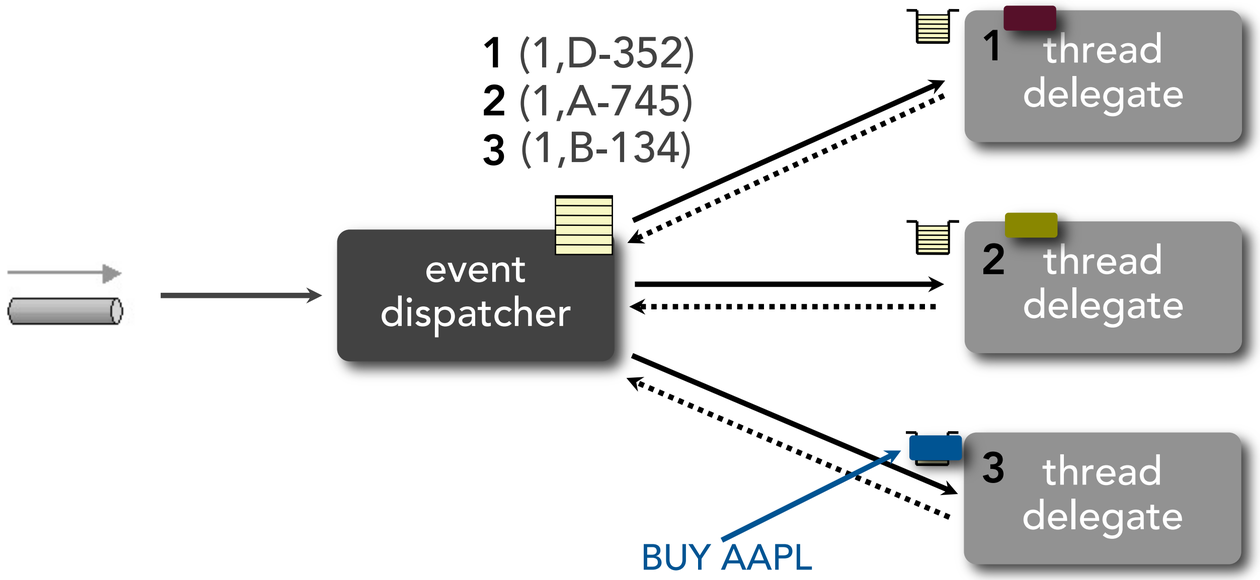

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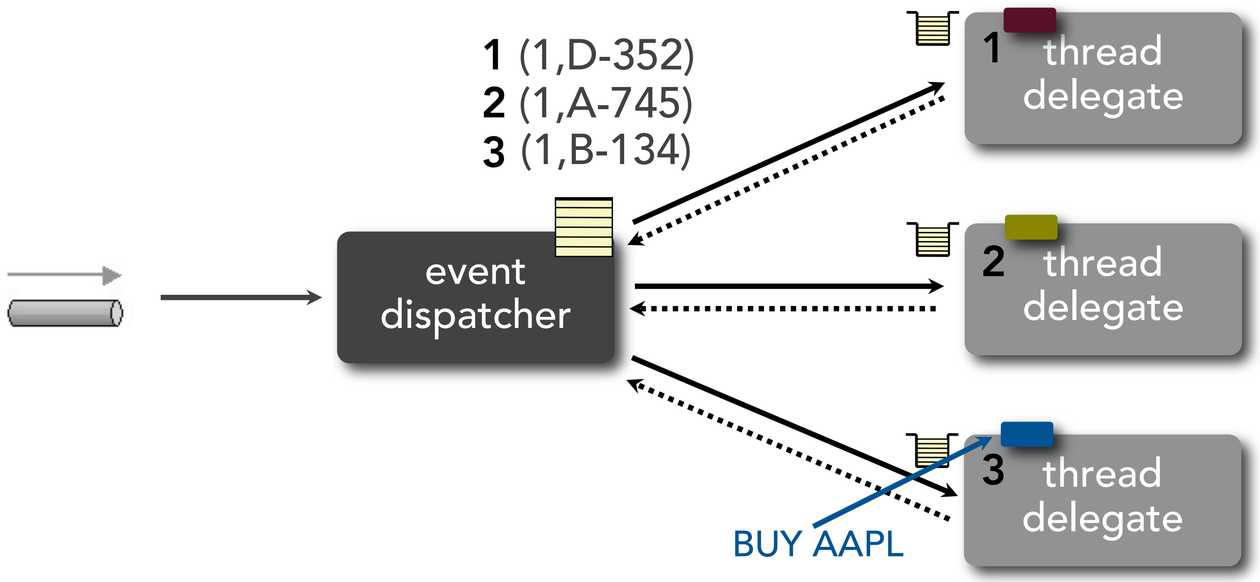

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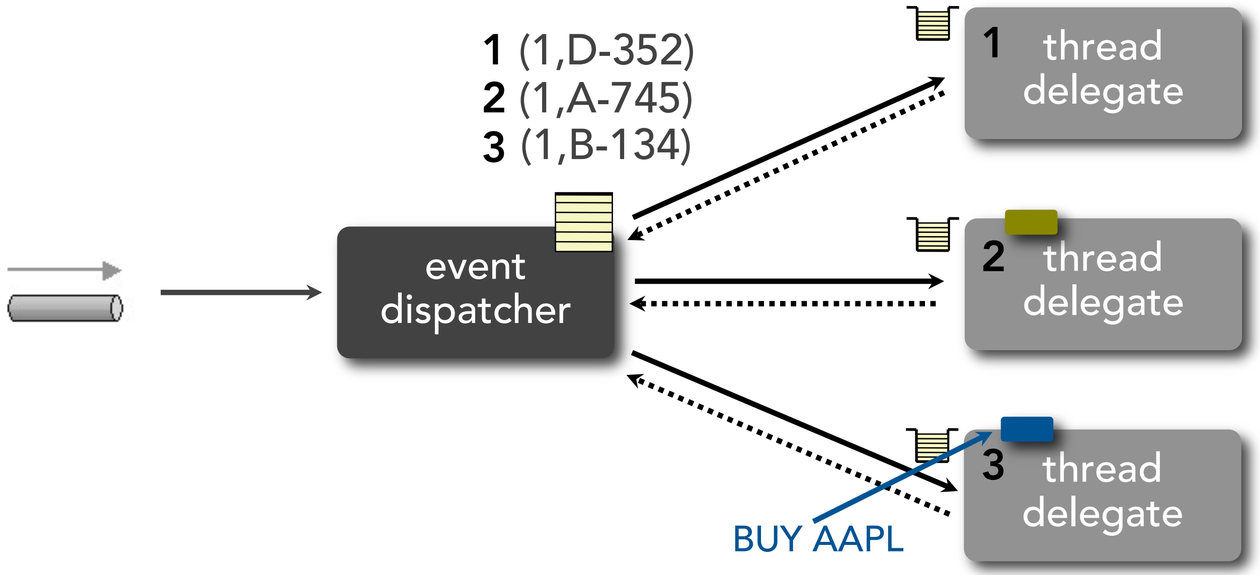

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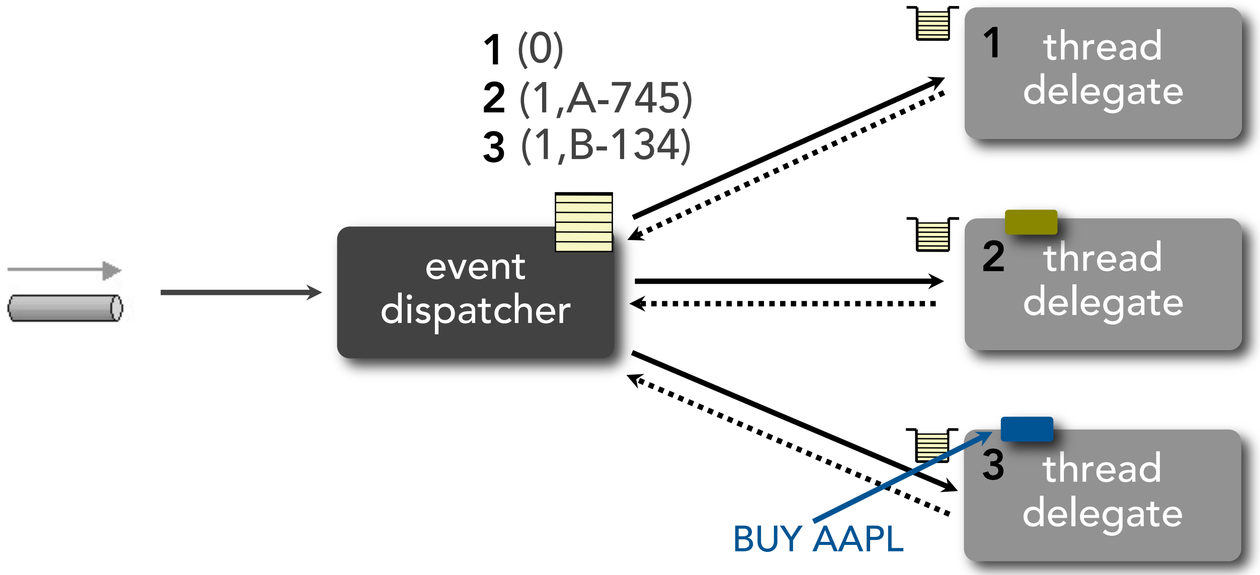

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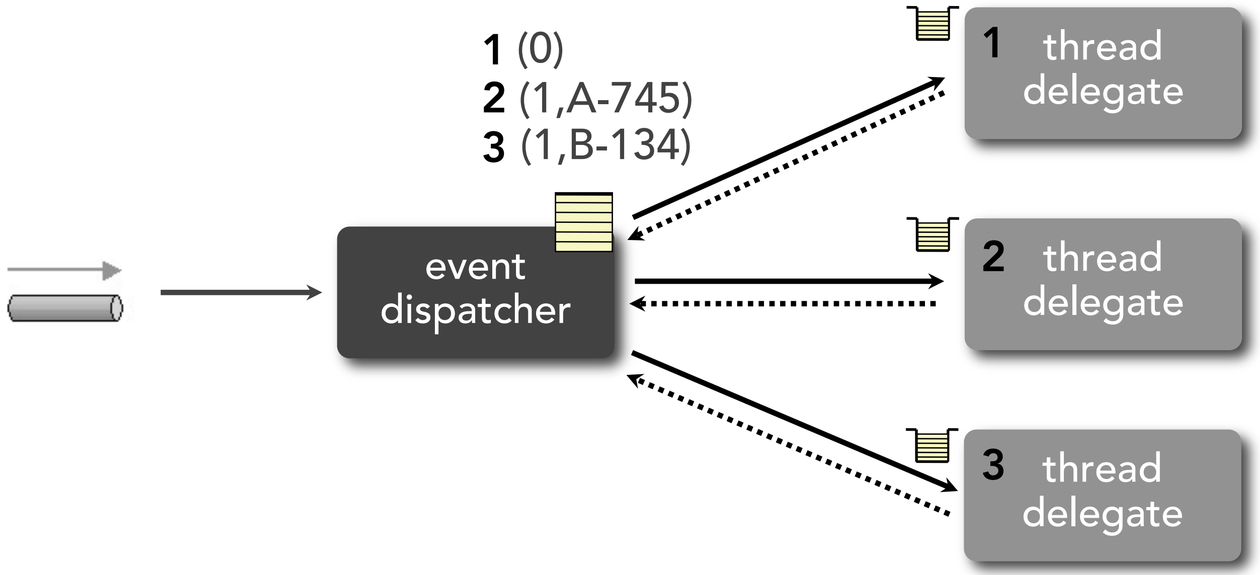

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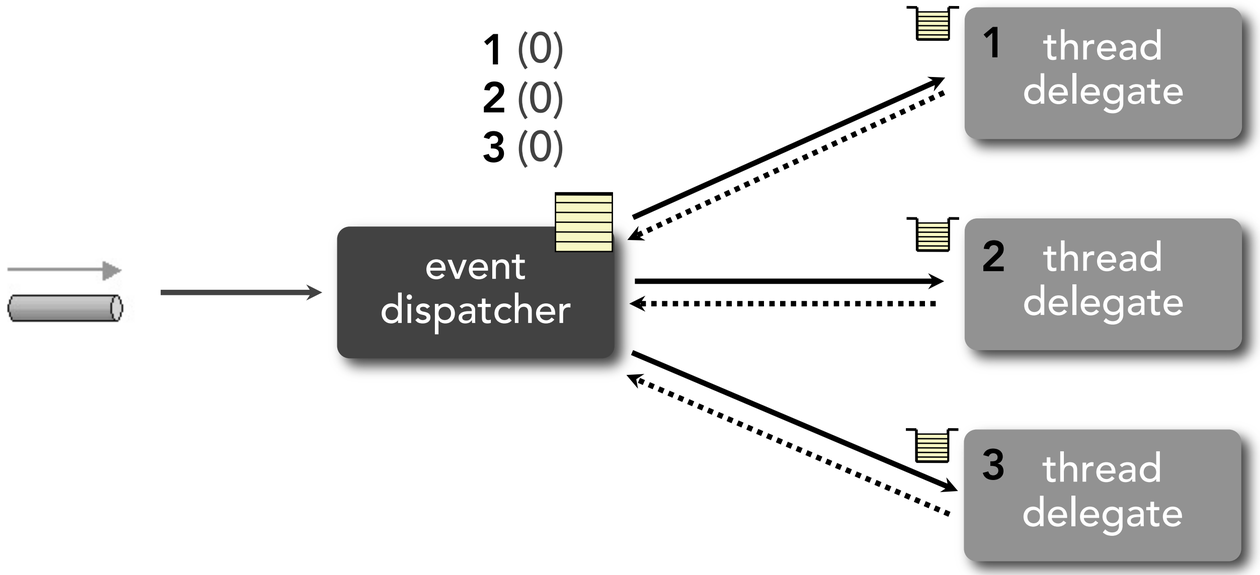

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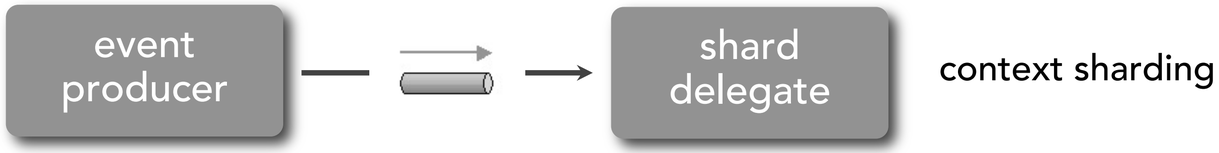

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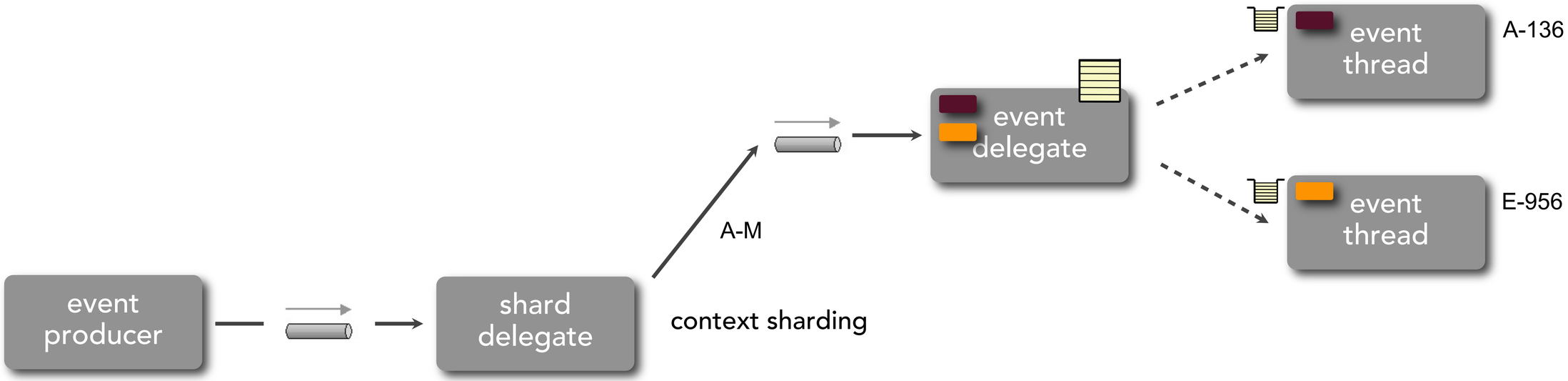

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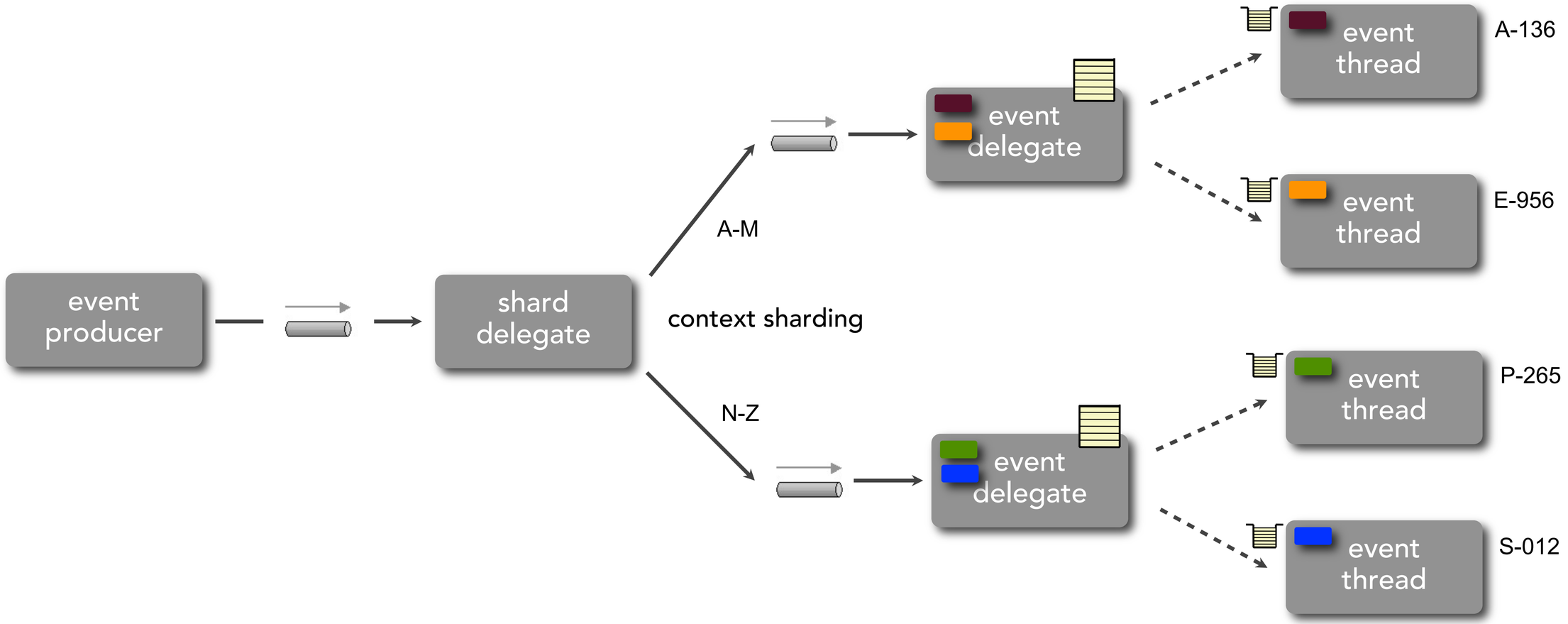

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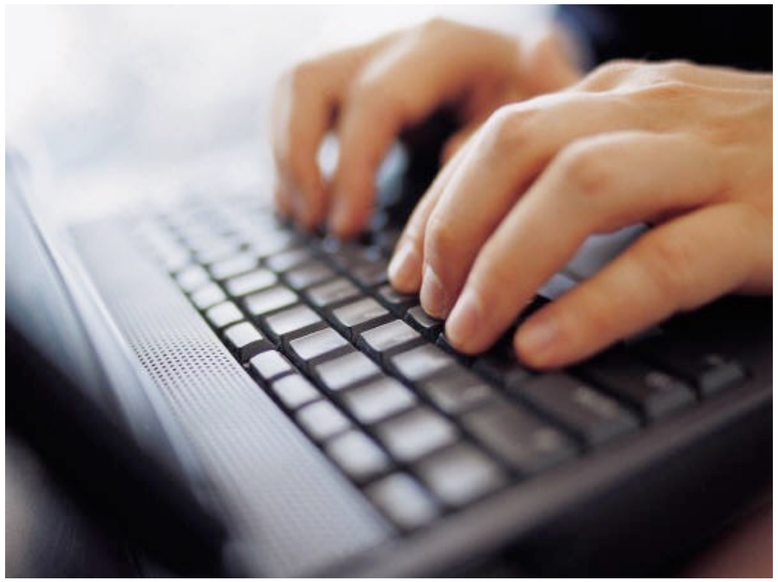
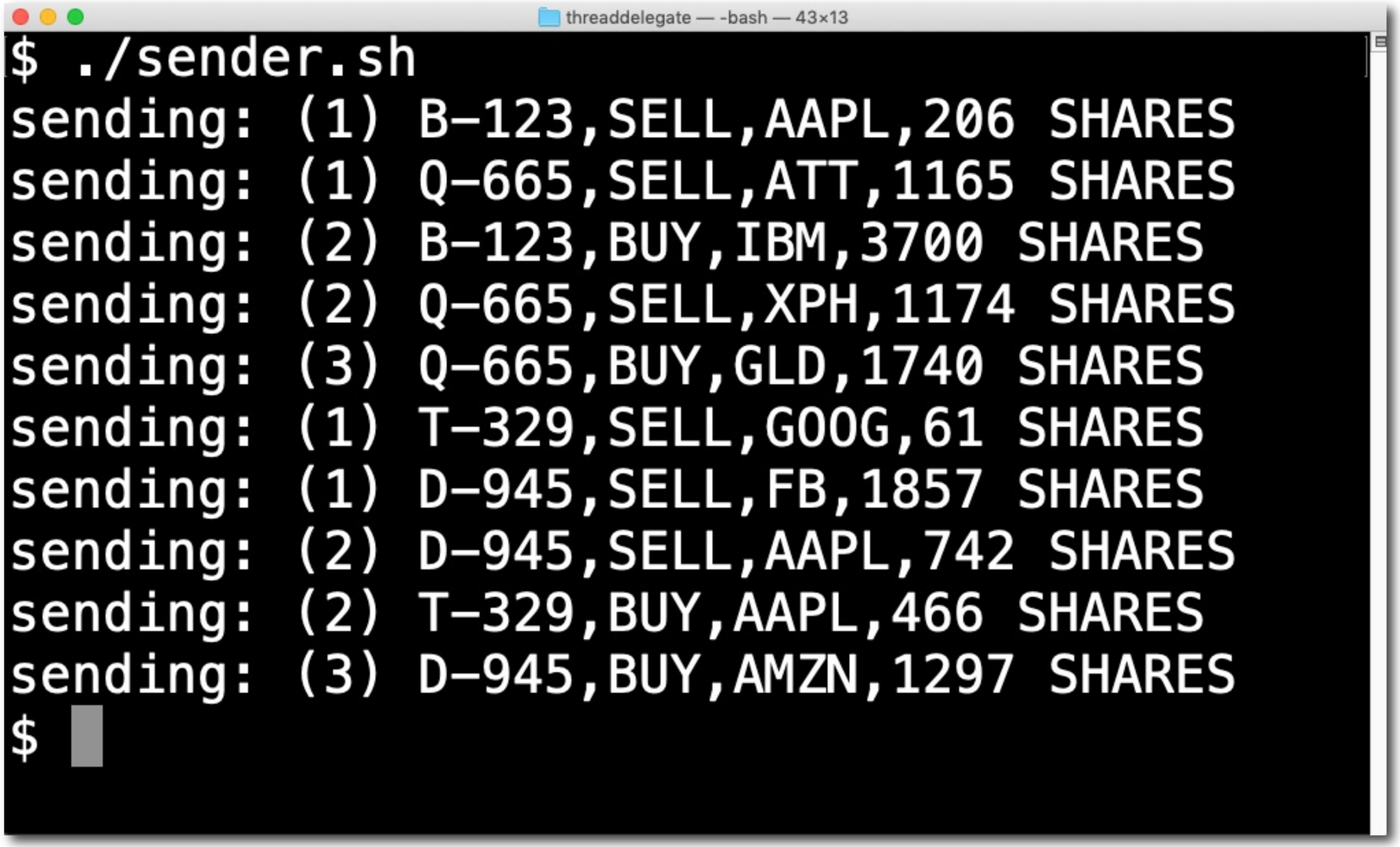


let’s apply the pattern…

thread delegate pattern



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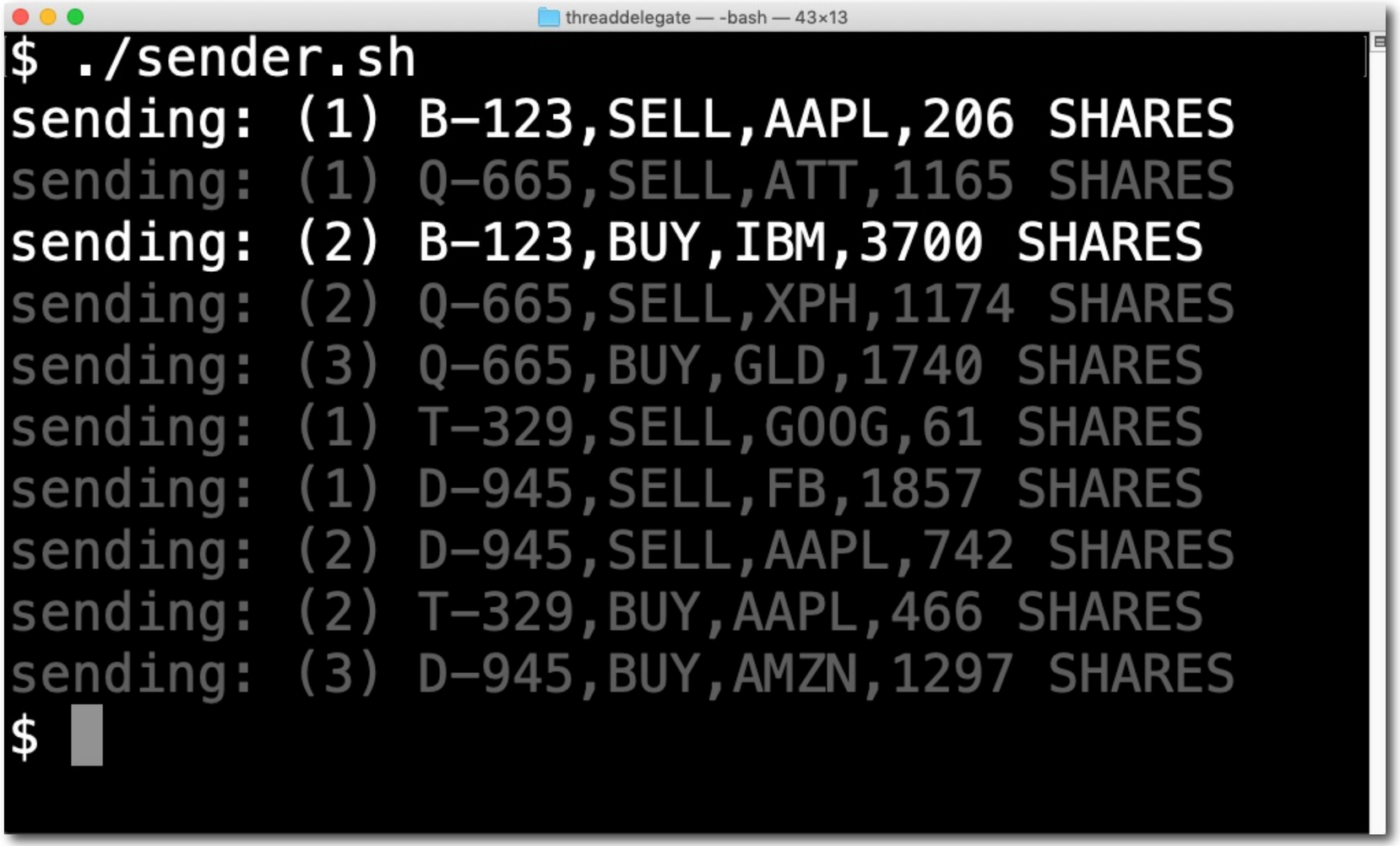

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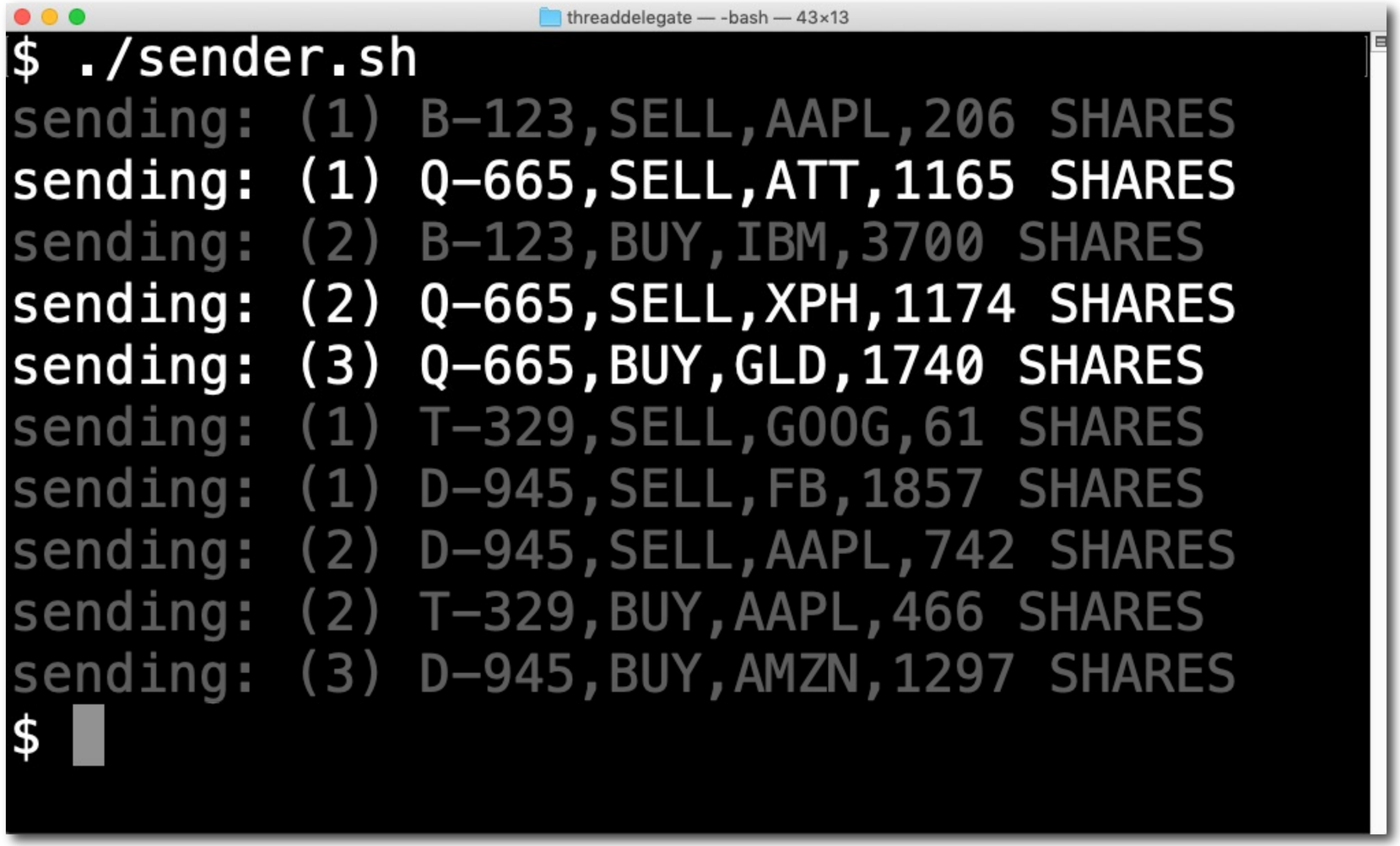

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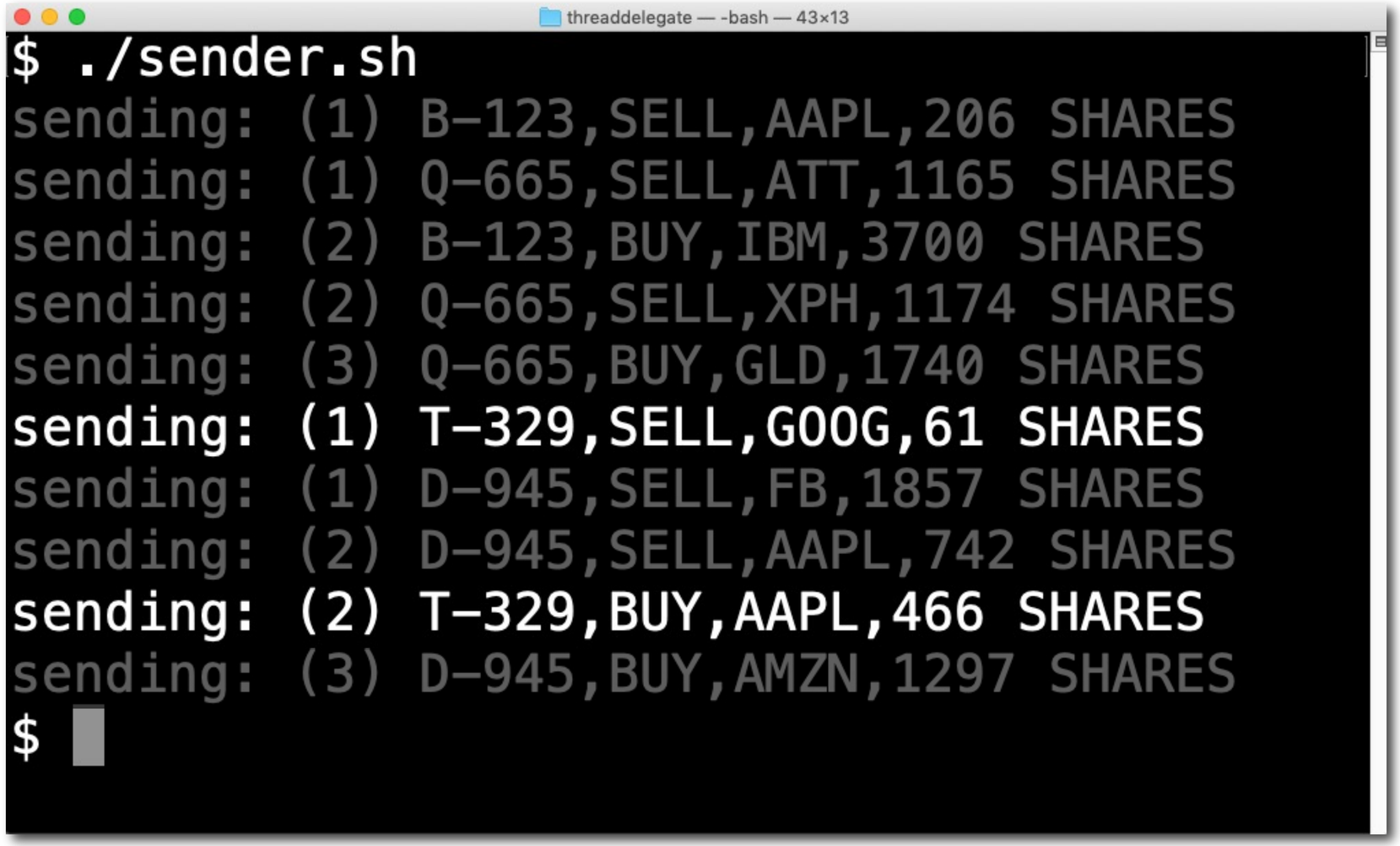

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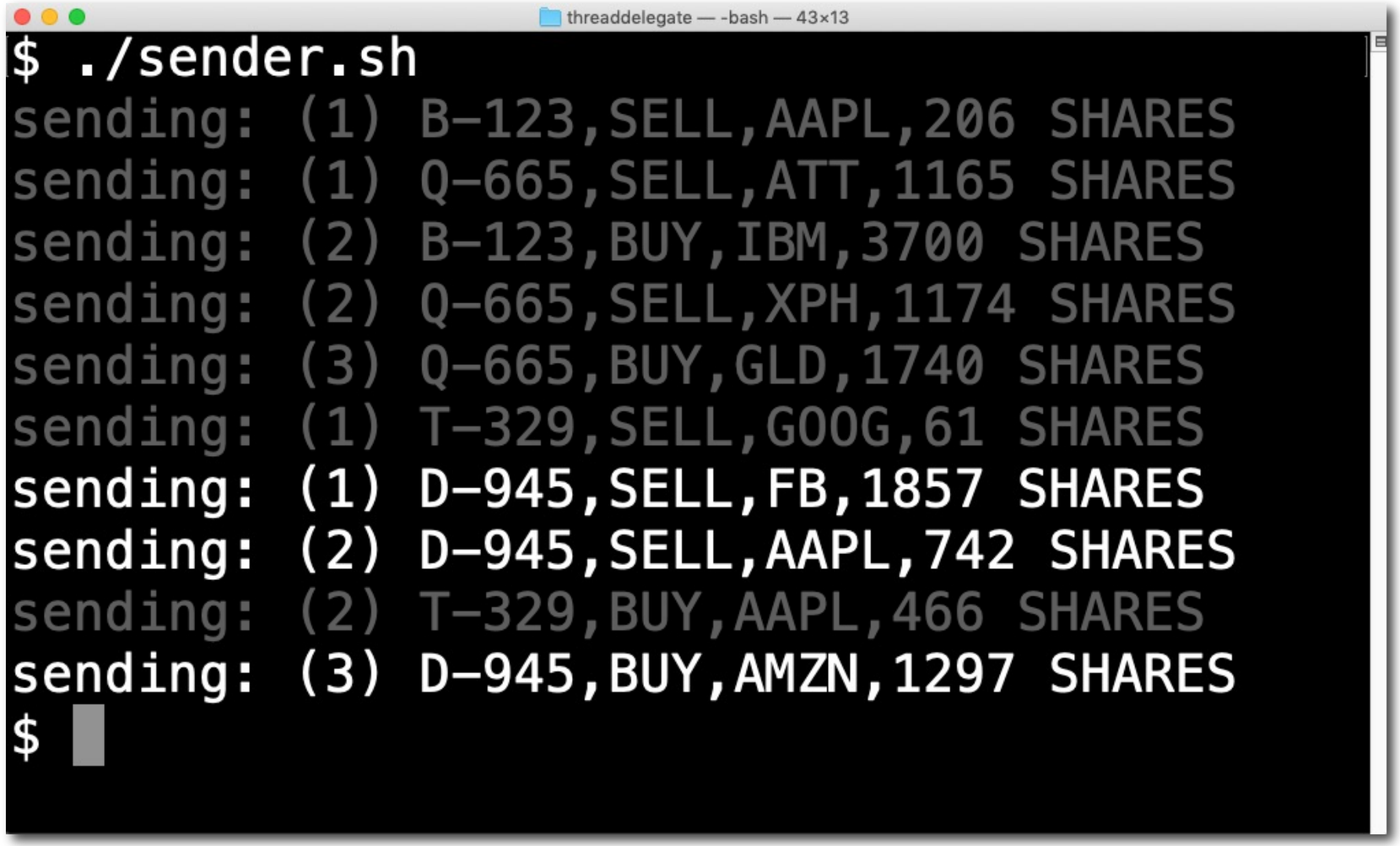

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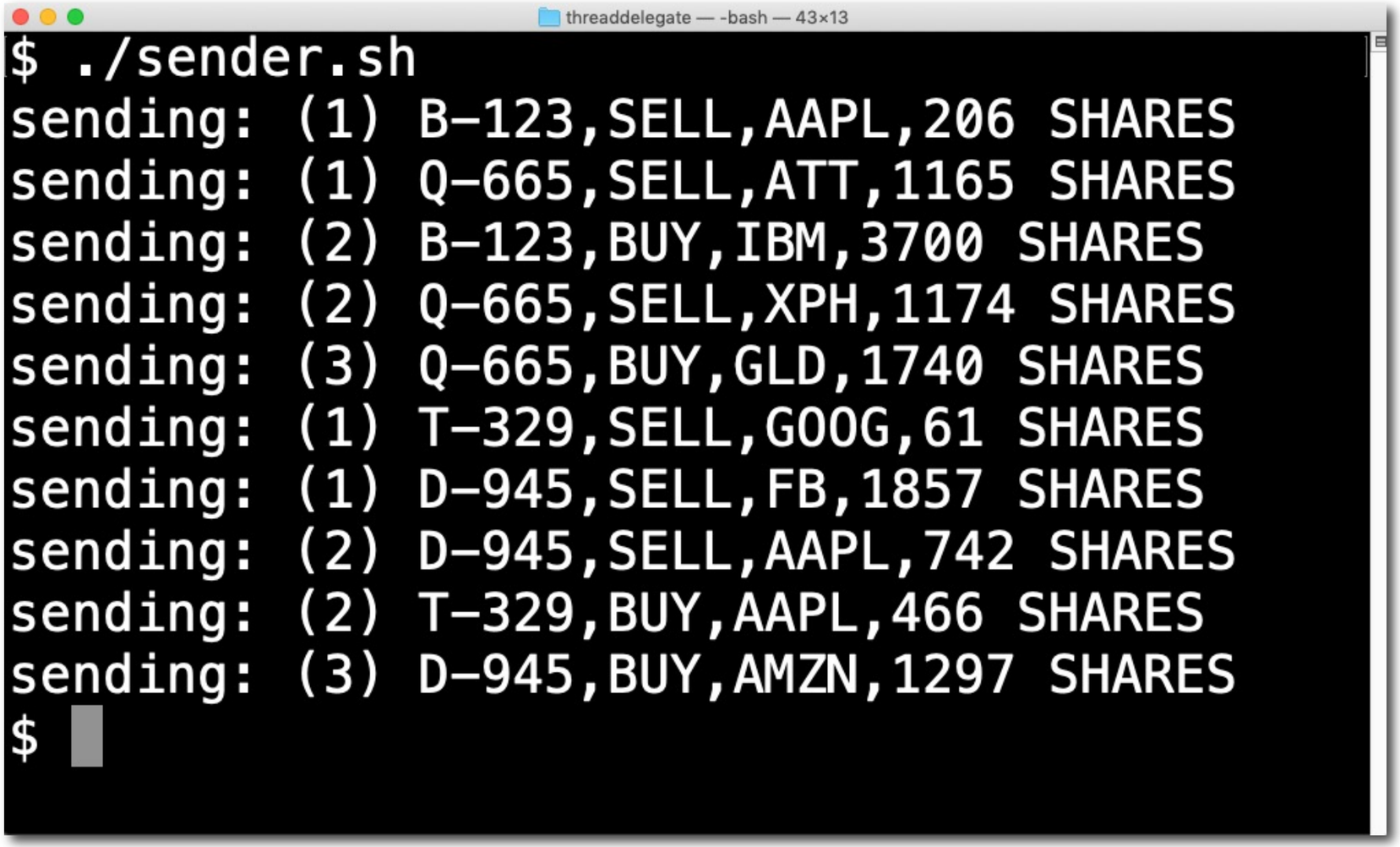
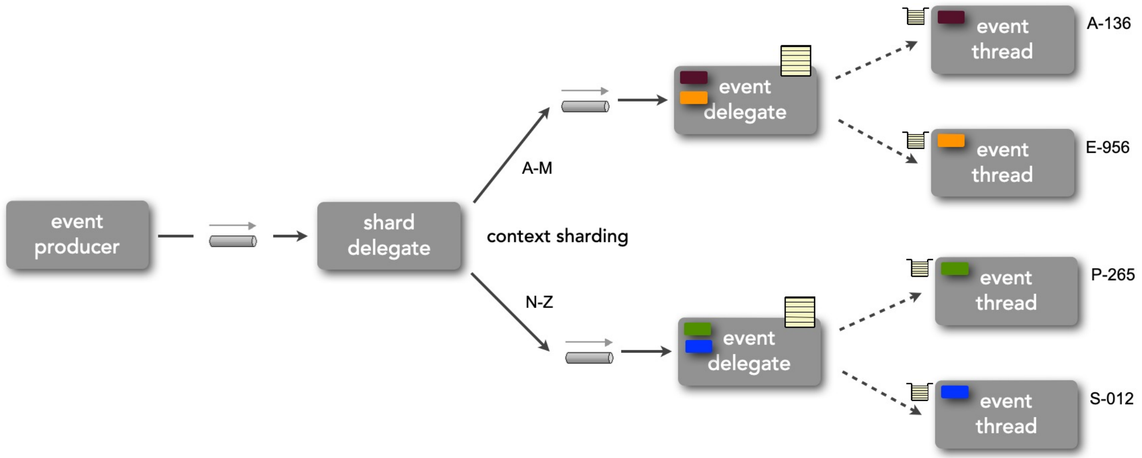
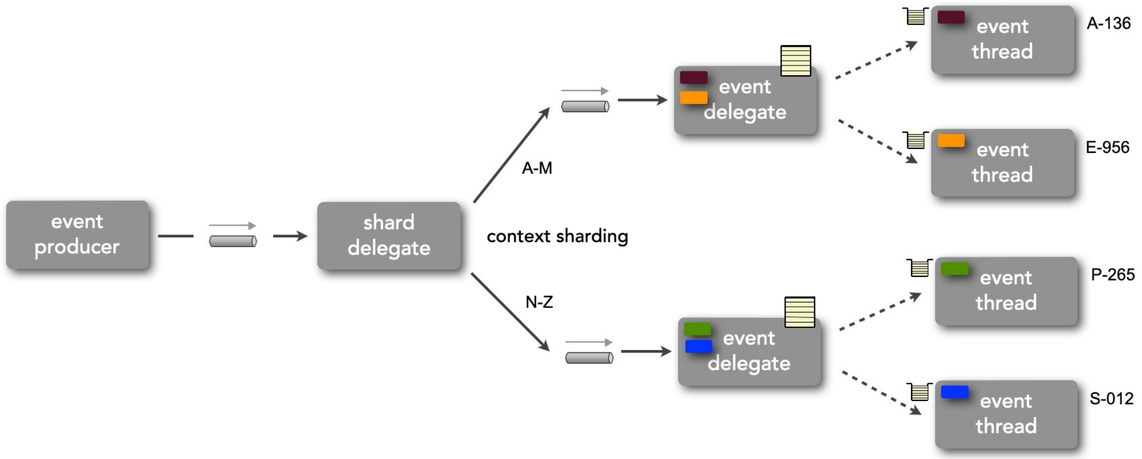


thread delegate pattern



thread delegate pattern



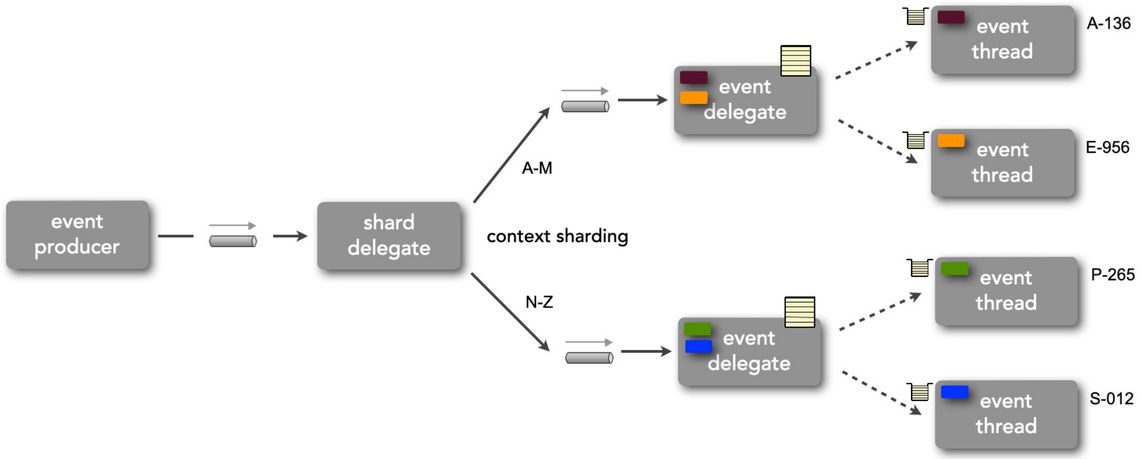
maintain processing order

increase throughput

increase performance

increase scalability

thread delegate pattern



maintain processing order

increase throughput

increase performance

increase scalability

increased complexity

possible thread saturation

complex error handling

increased cost

Ambulance Pattern (Carpool)

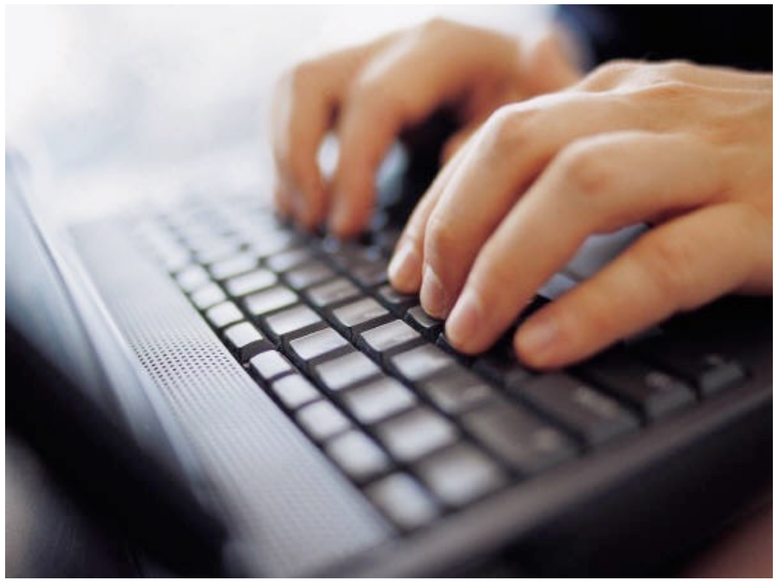
ambulance pattern

https://github.com/wmr513/event-driven-patterns/tree/master/ambulance

ambulance pattern

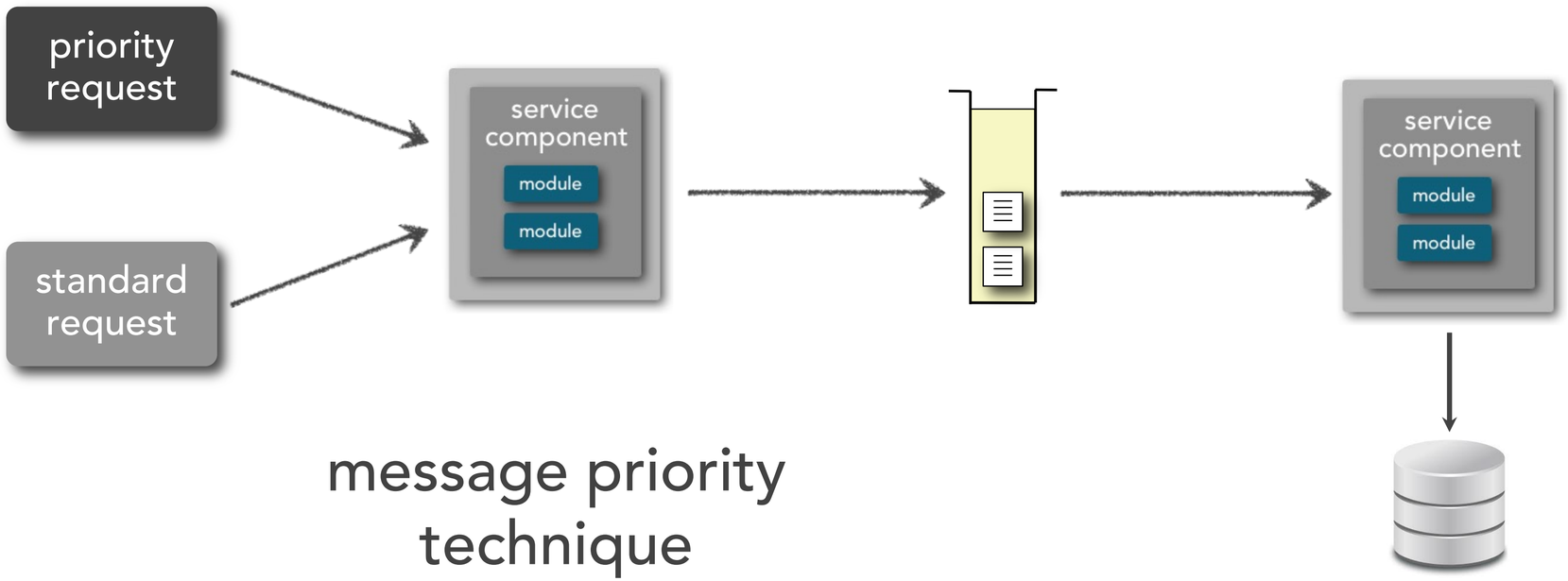
“how can I give some events a higher priority and still maintain responsiveness for all other events?”

ambulance pattern



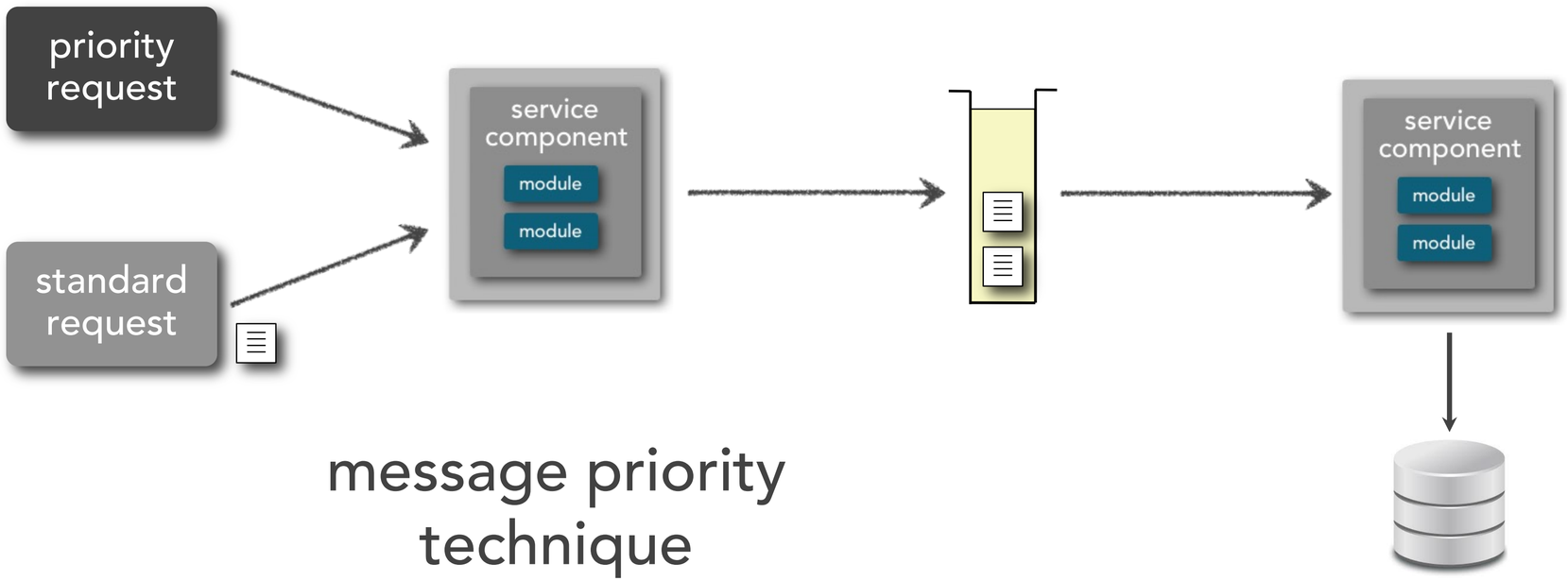
let’s see the issue…

ambulance pattern



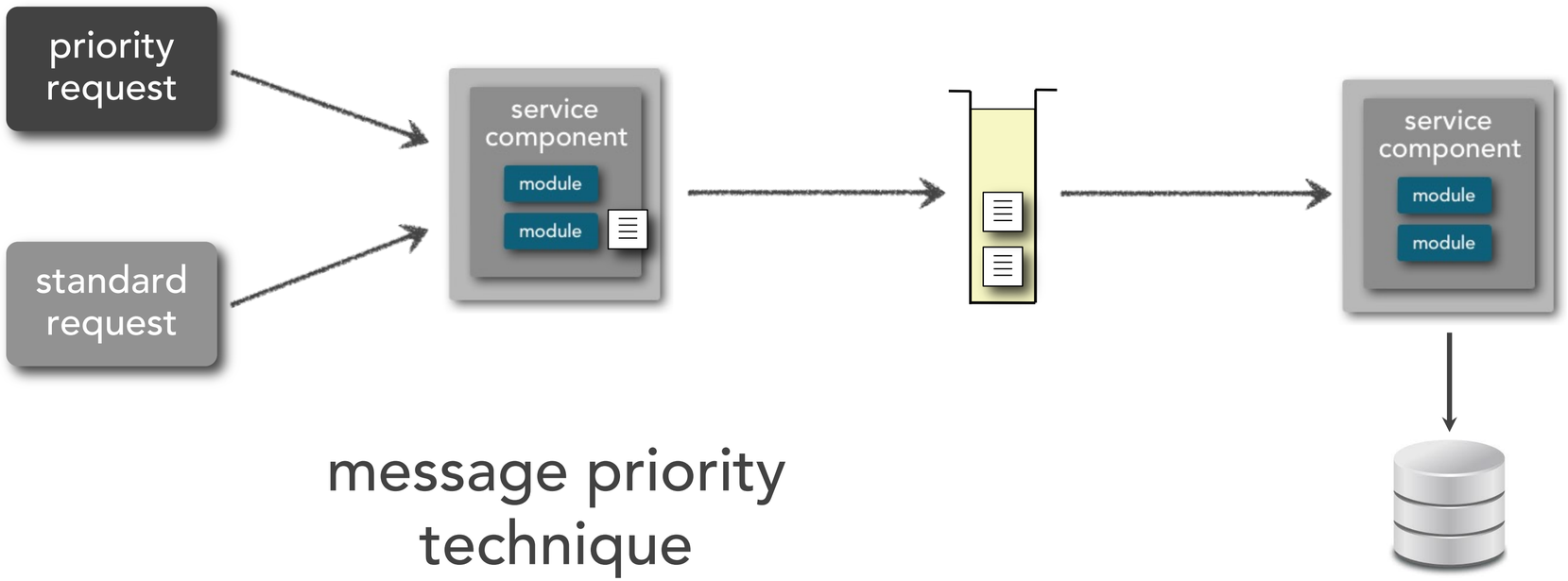
message priority technique

ambulance pattern



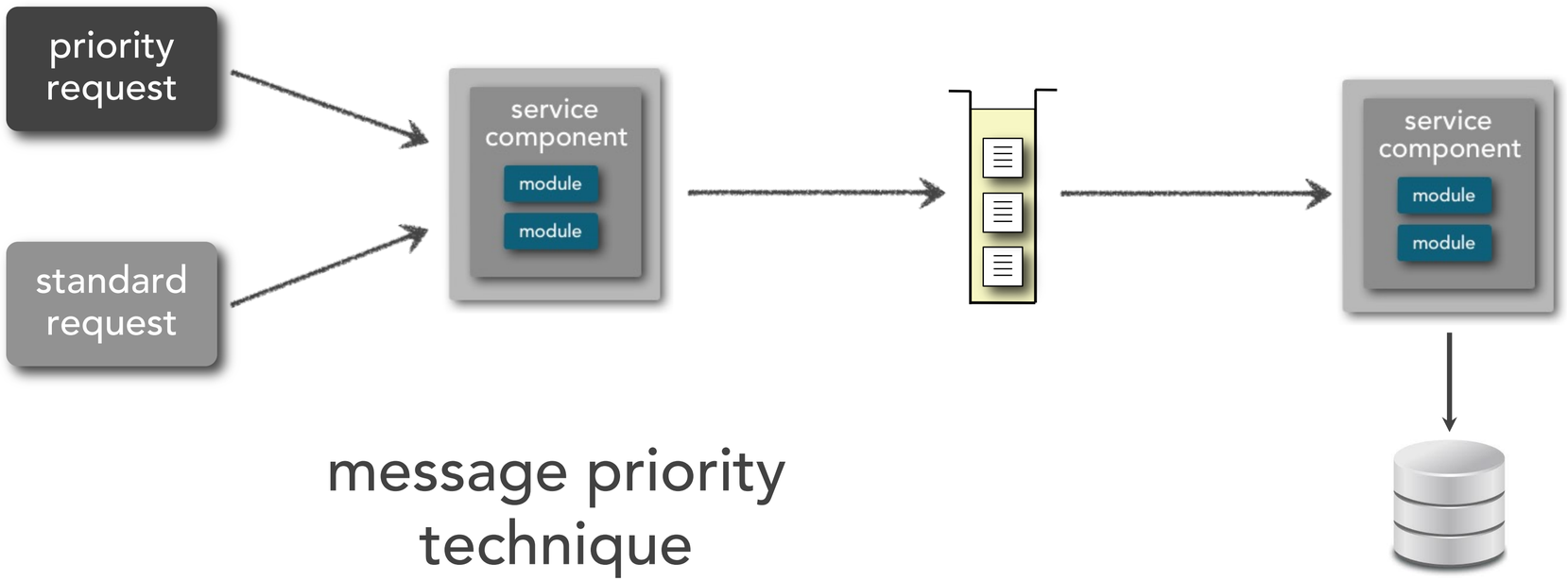
message priority technique

ambulance pattern



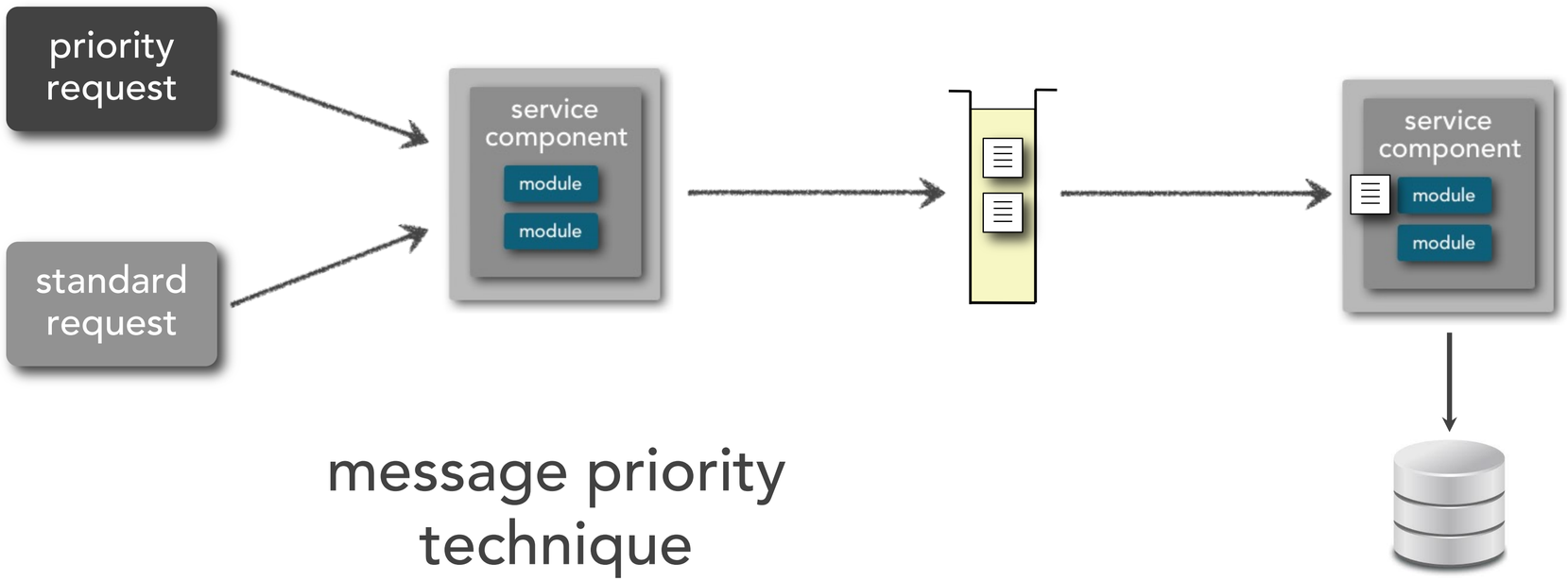
message priority technique

ambulance pattern



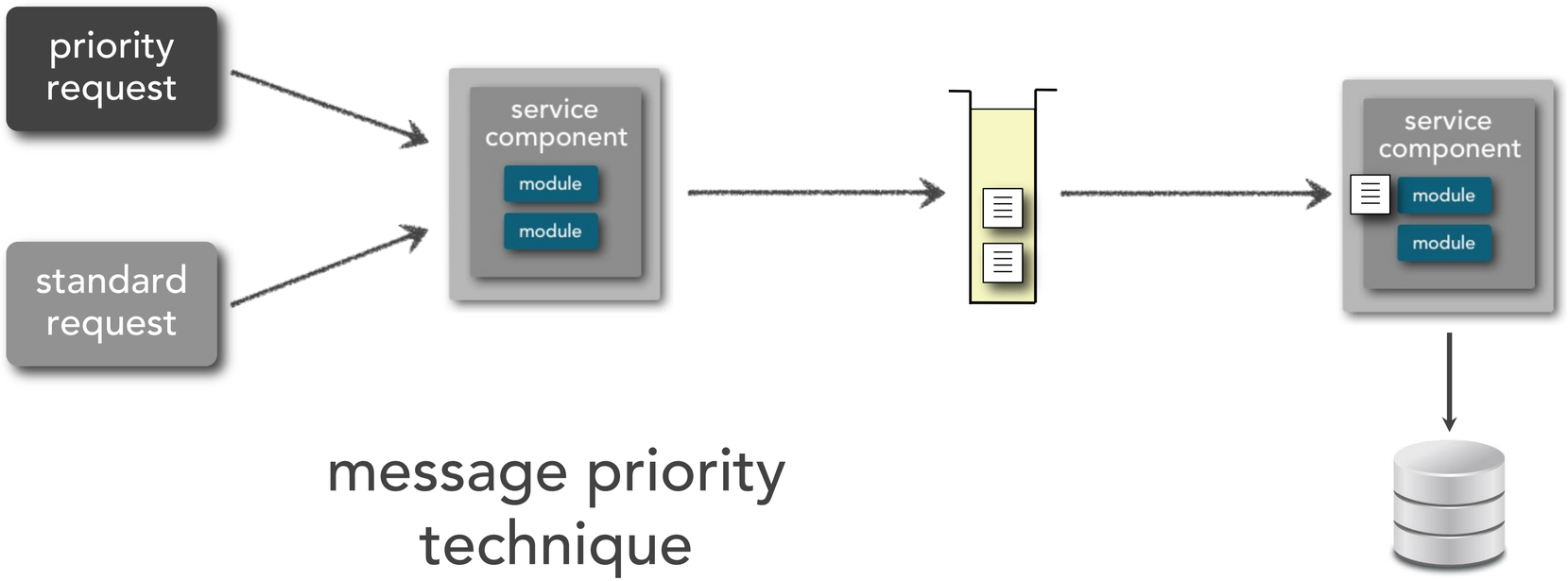
message priority technique

ambulance pattern



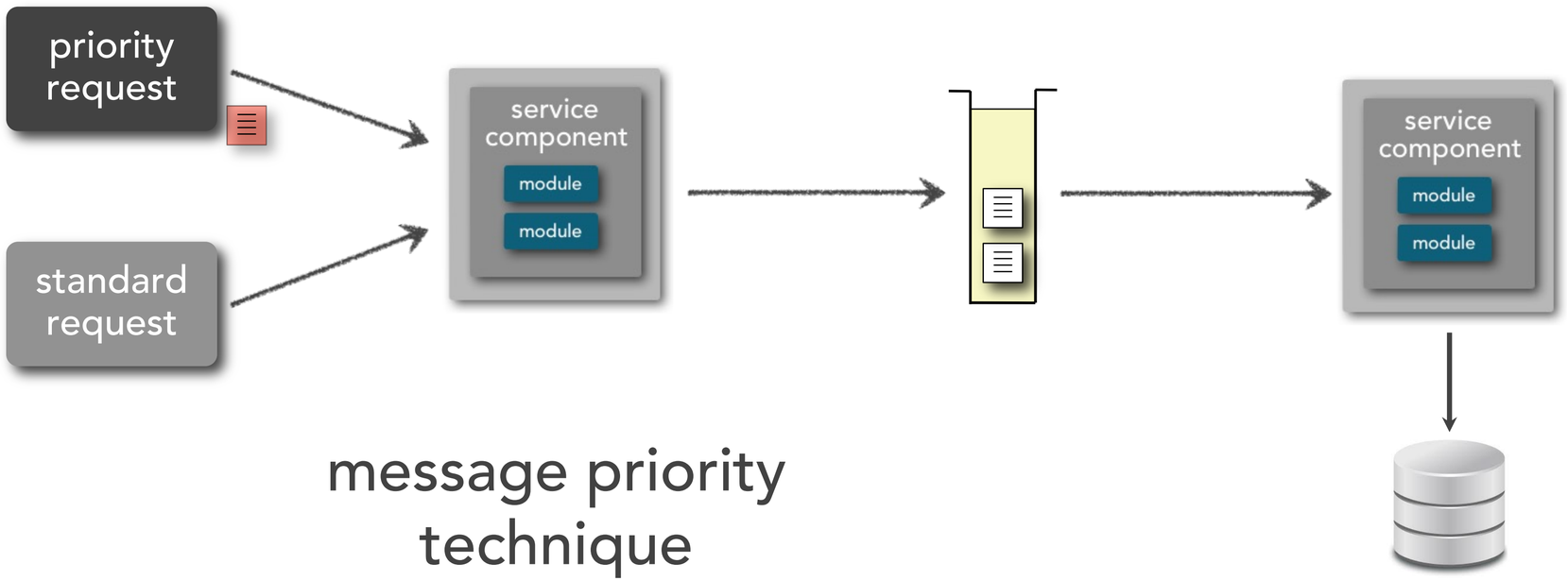
message priority technique

ambulance pattern



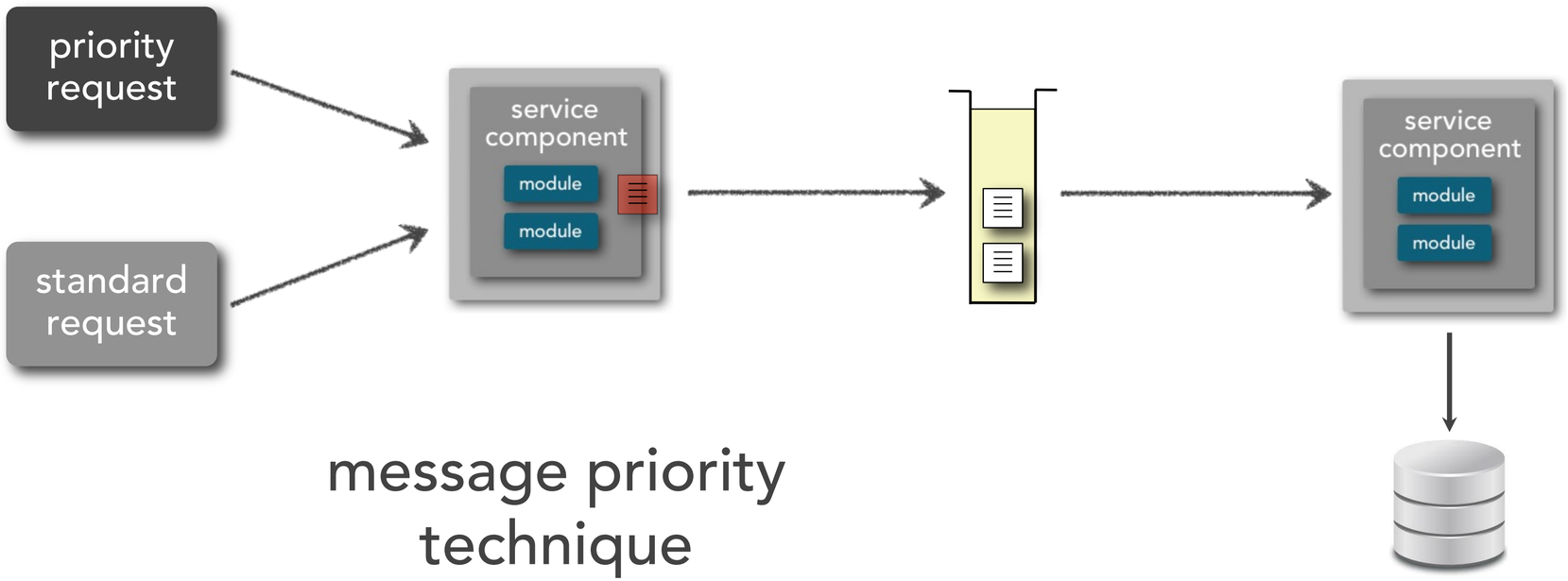
message priority technique

ambulance pattern



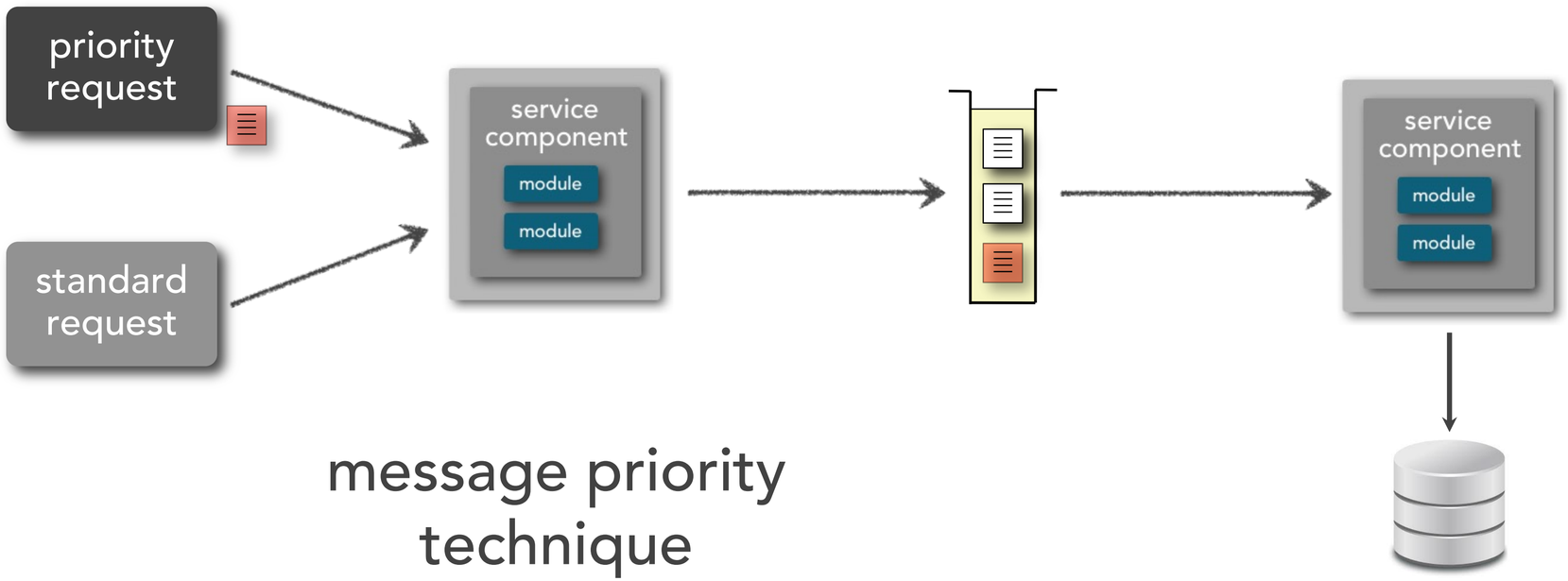
message priority technique

ambulance pattern



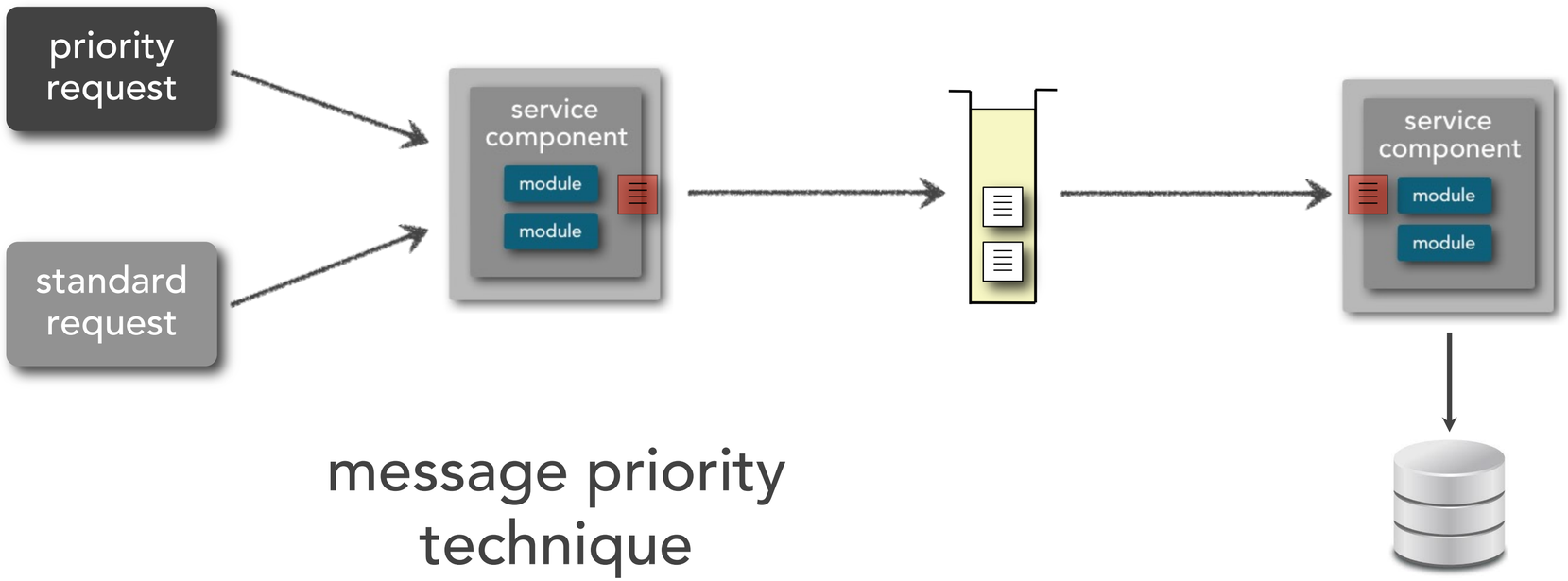
message priority technique

ambulance pattern



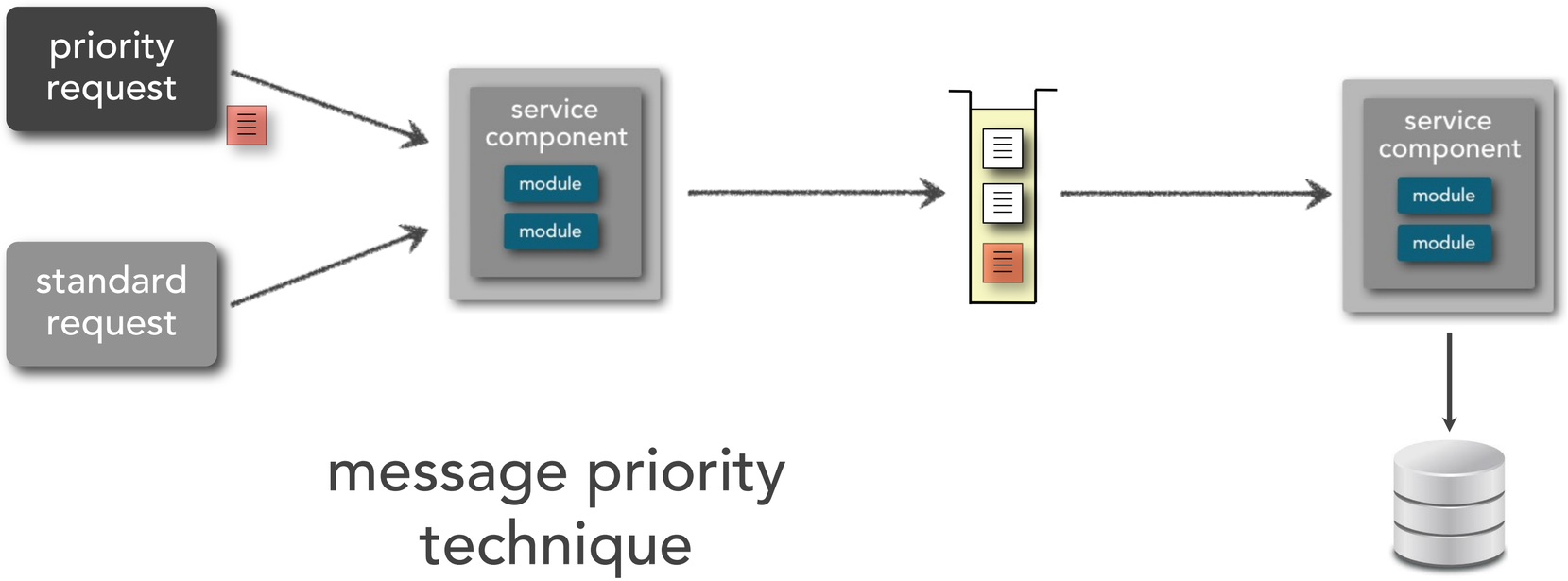
message priority technique

ambulance pattern



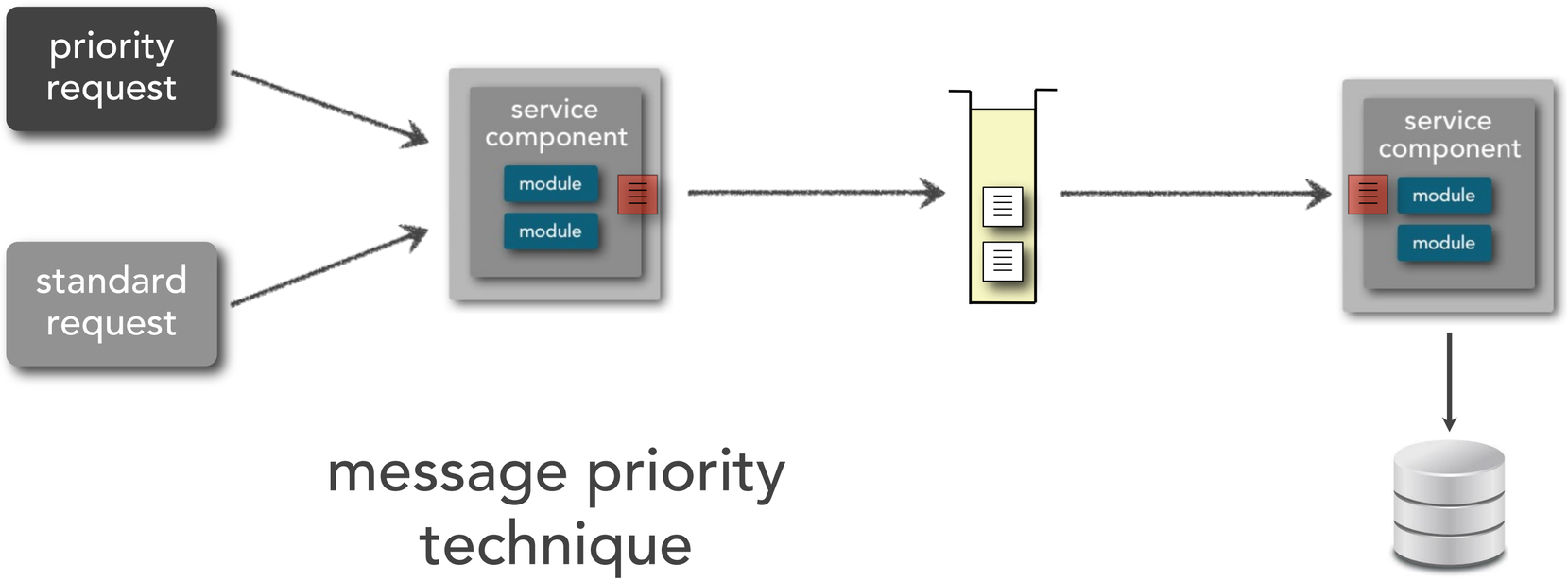
message priority technique

ambulance pattern



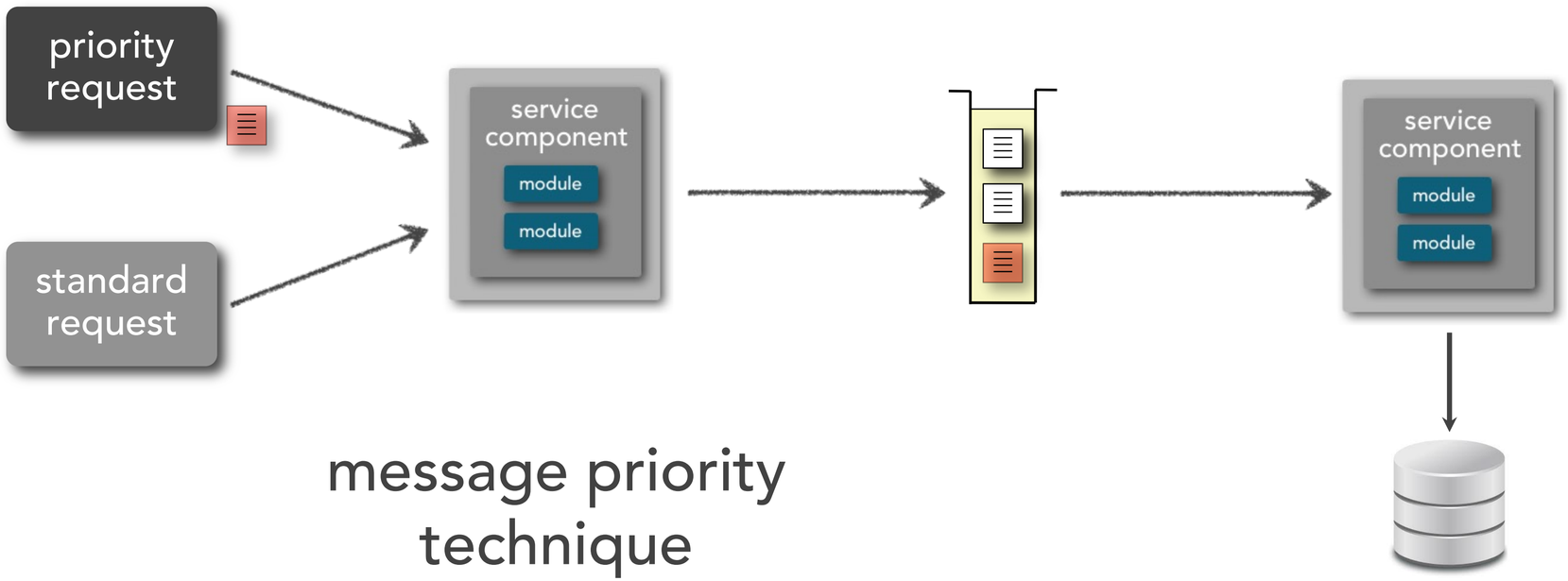
message priority technique

ambulance pattern



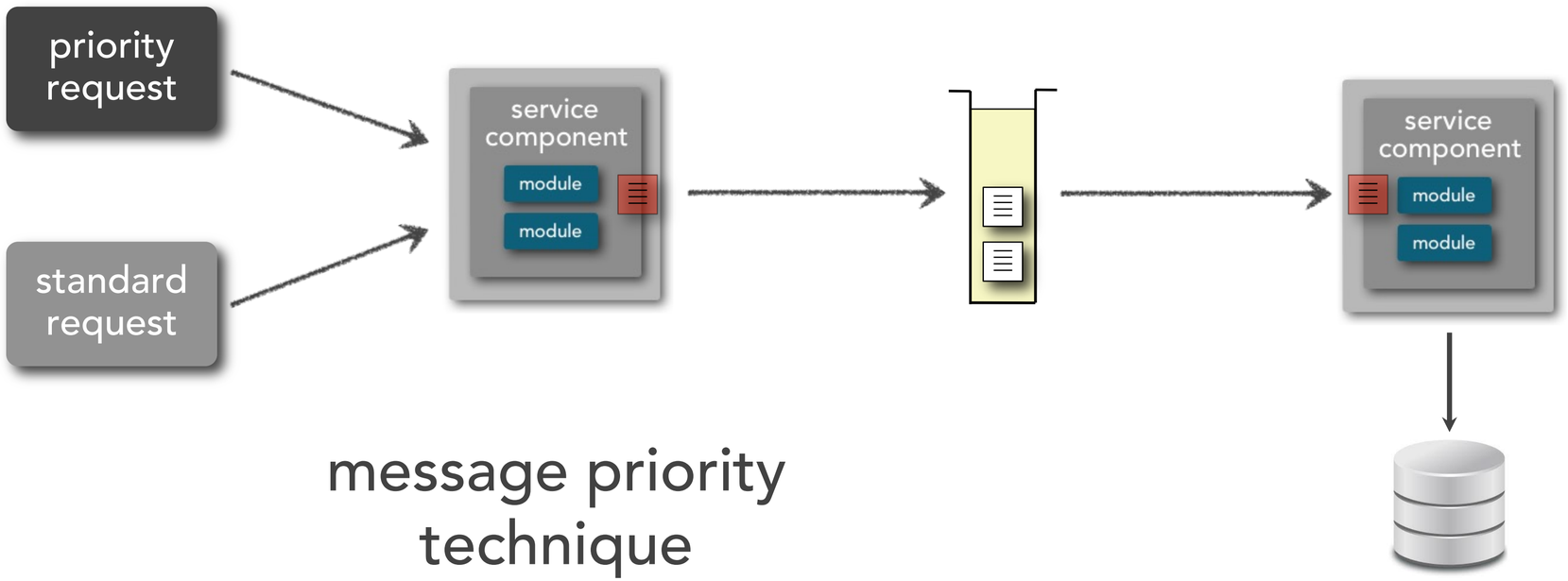
message priority technique

ambulance pattern



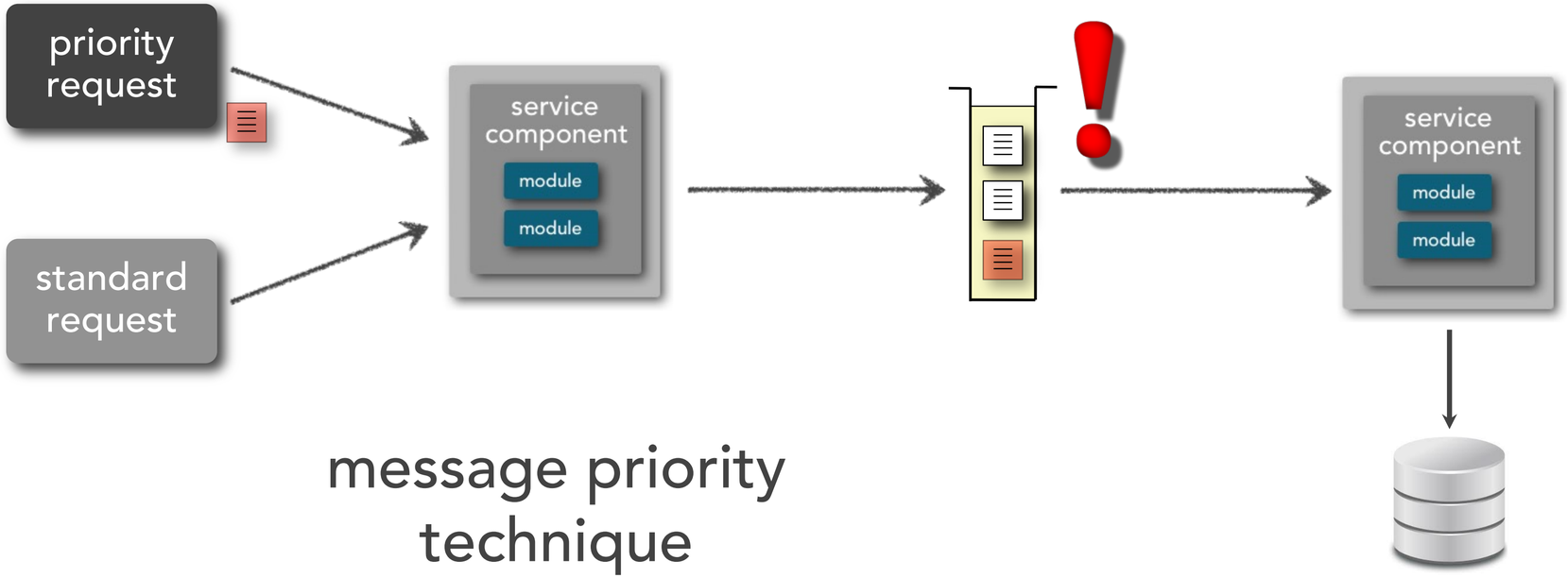
message priority technique

ambulance pattern



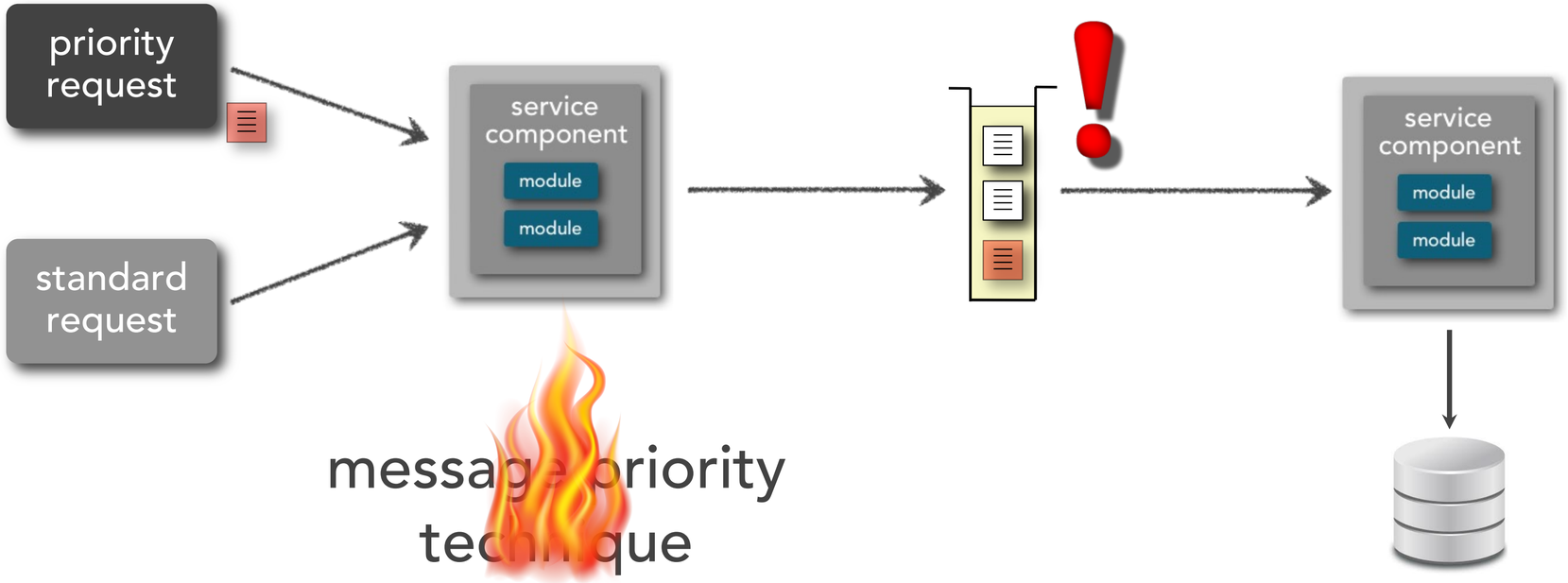
message priority technique

ambulance pattern



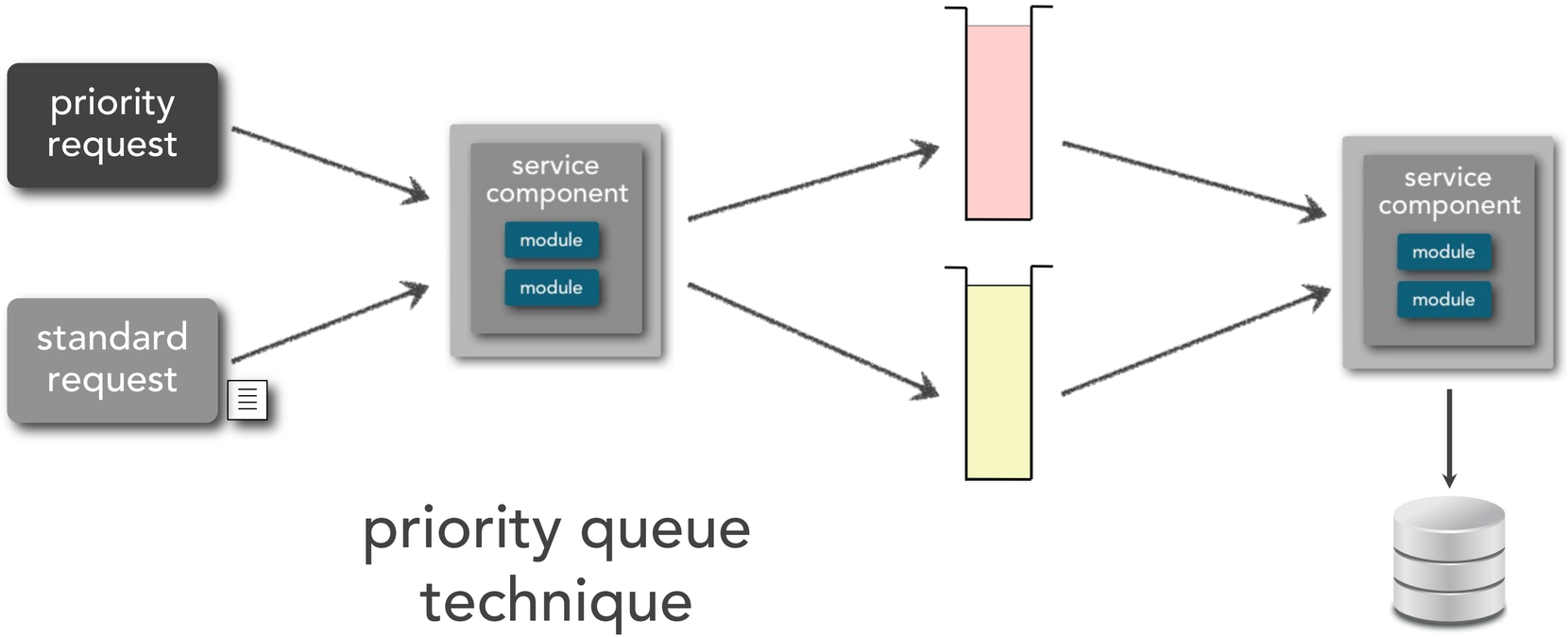
message priority technique

ambulance pattern



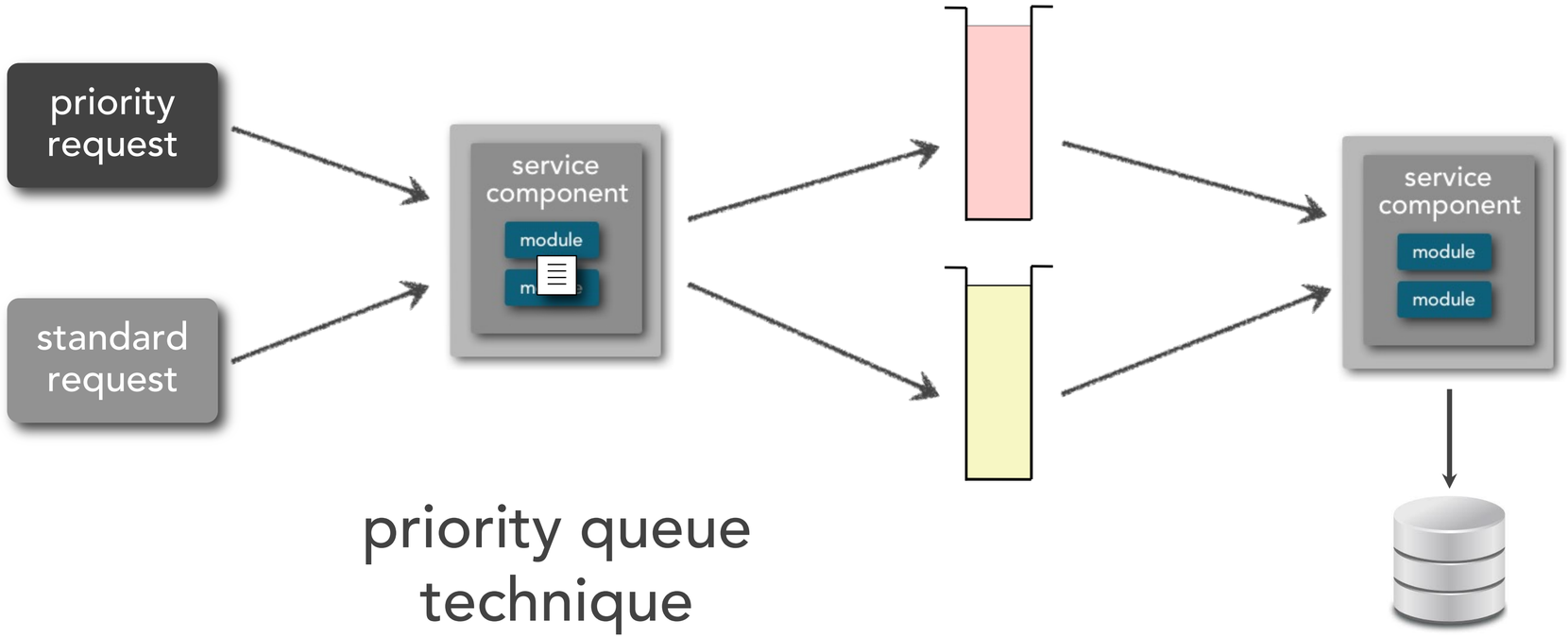
message priority technique

ambulance pattern



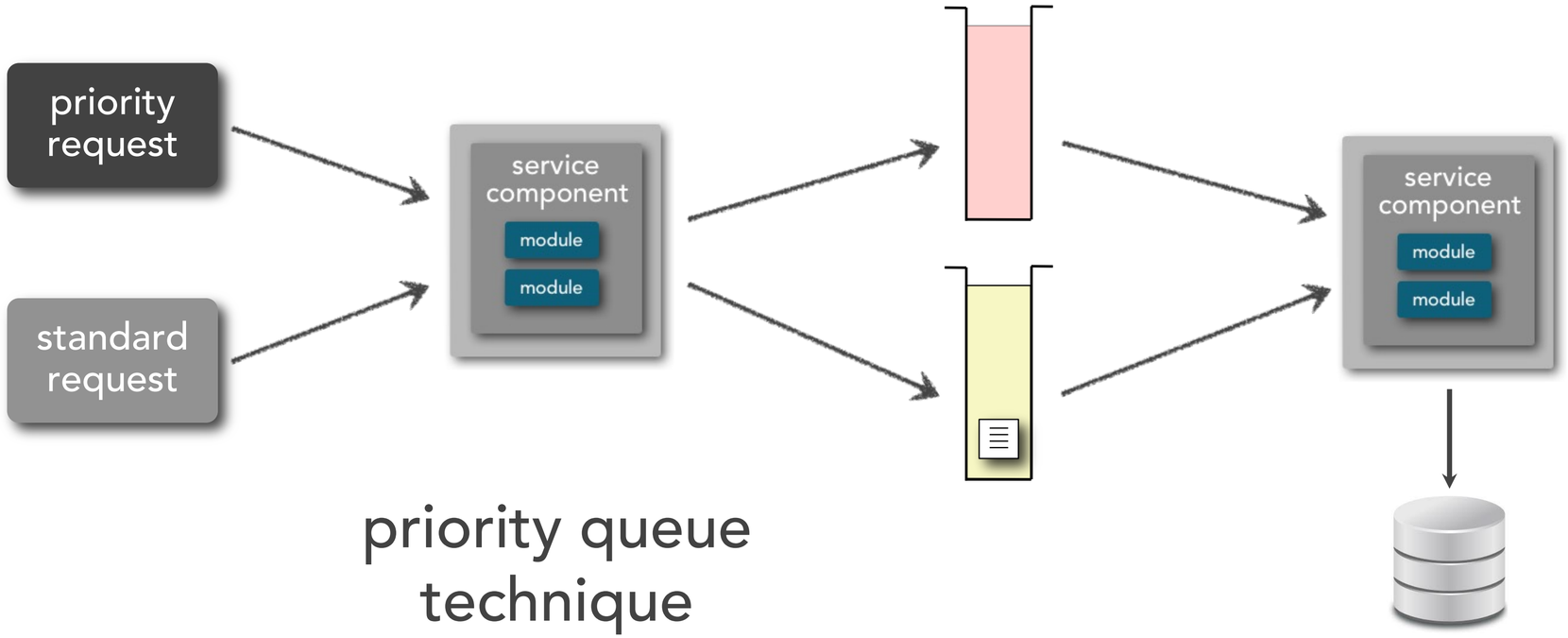
priority queue technique

ambulance pattern



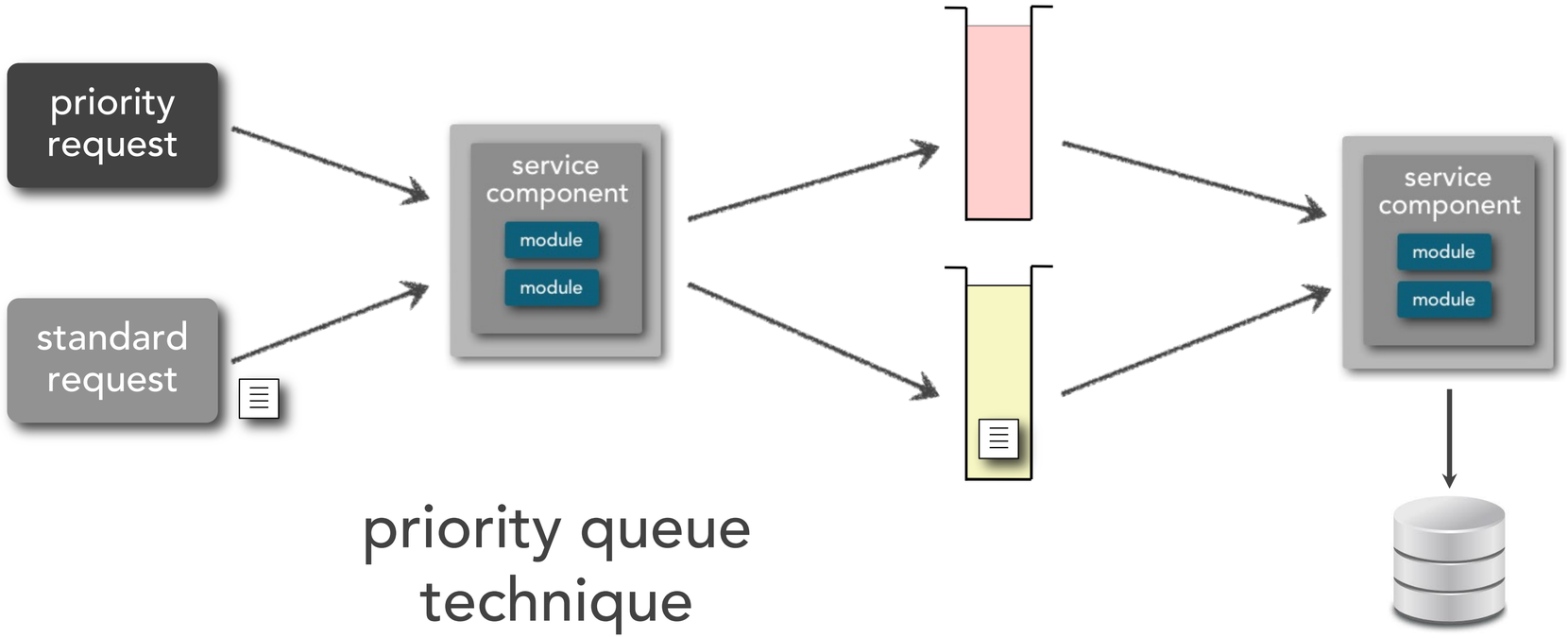
priority queue technique

ambulance pattern



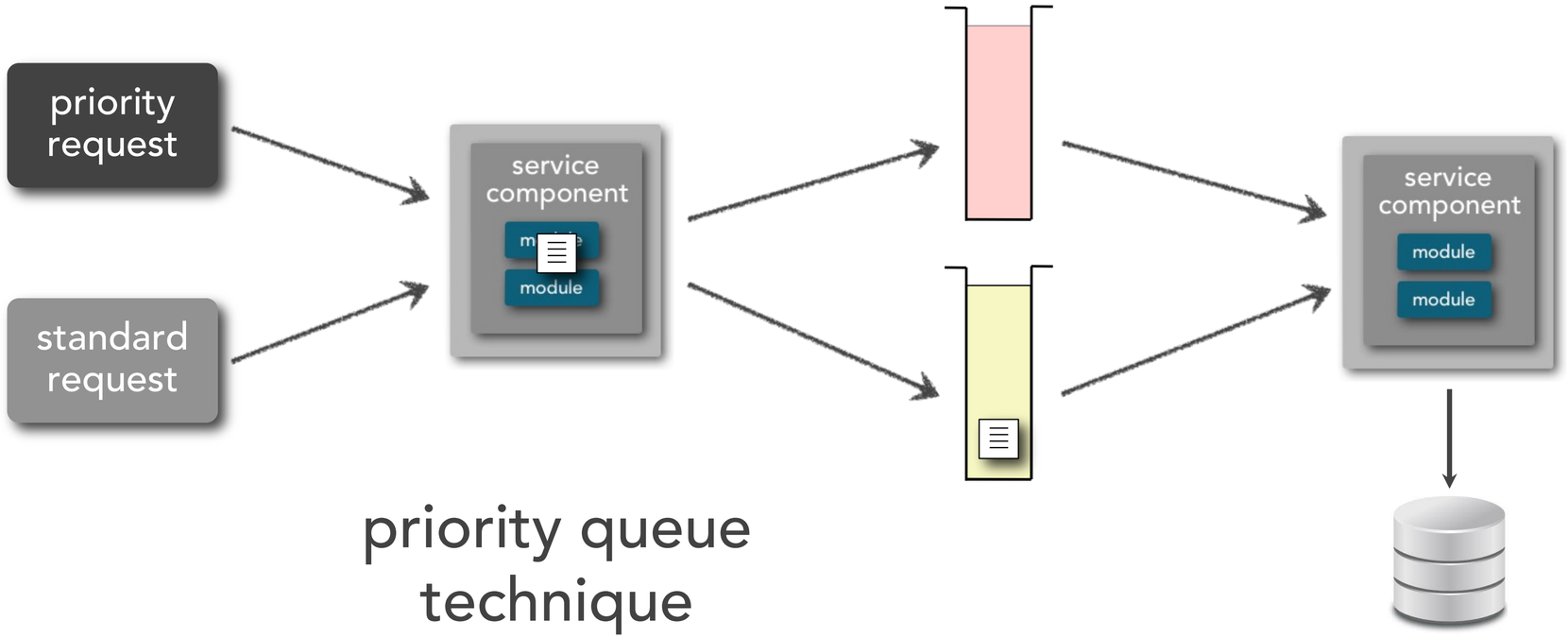
priority queue technique

ambulance pattern



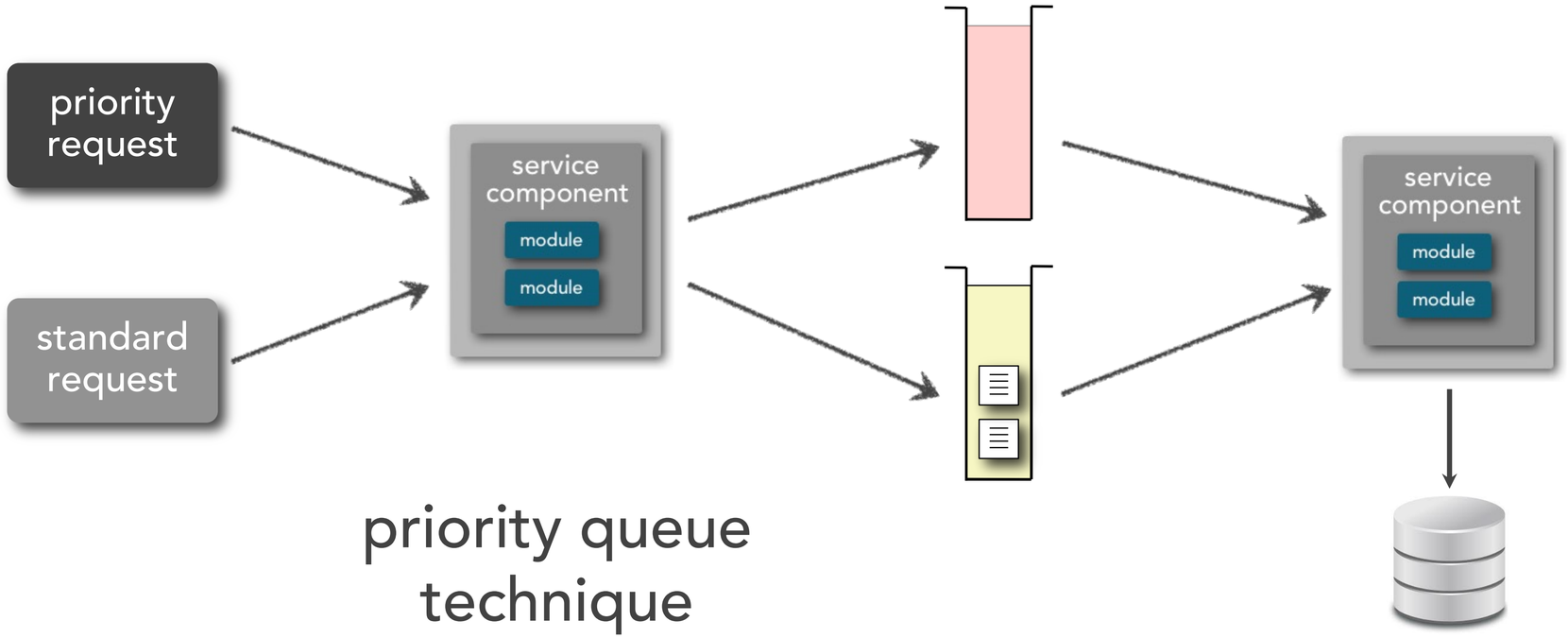
priority queue technique

ambulance pattern



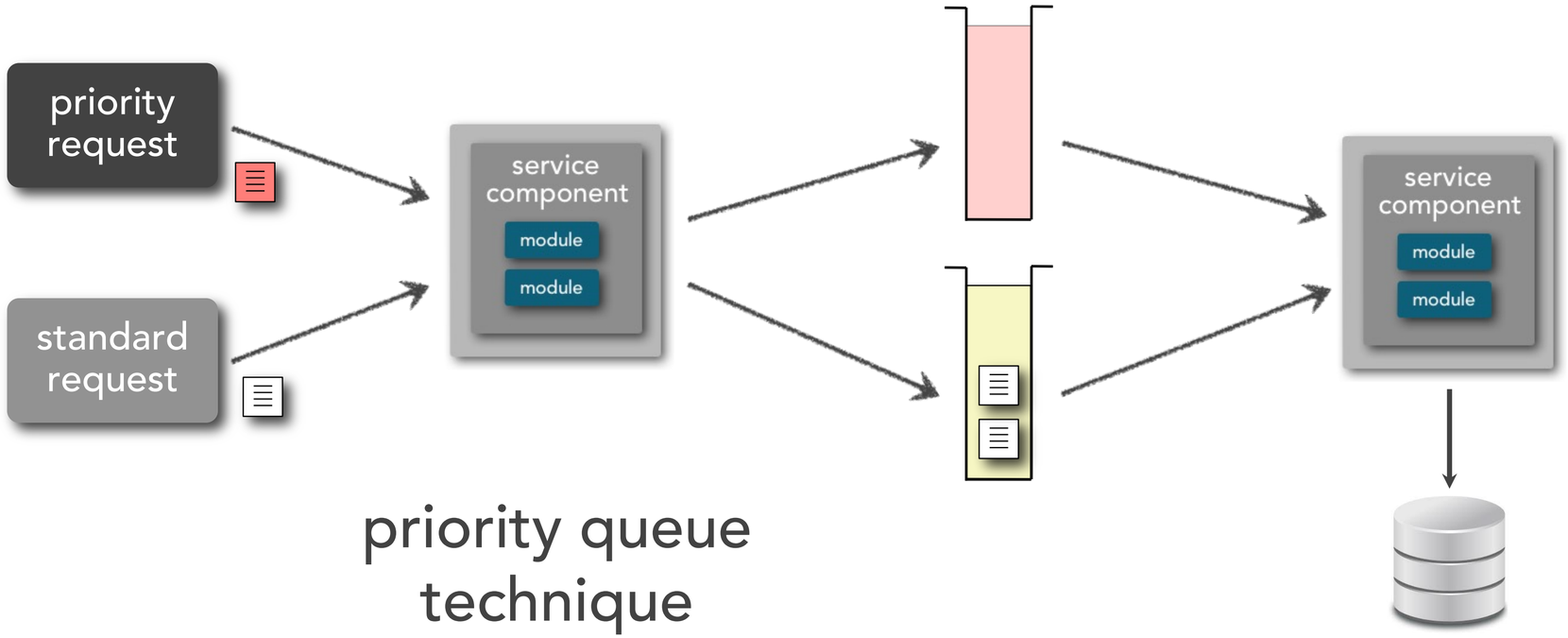
priority queue technique

ambulance pattern



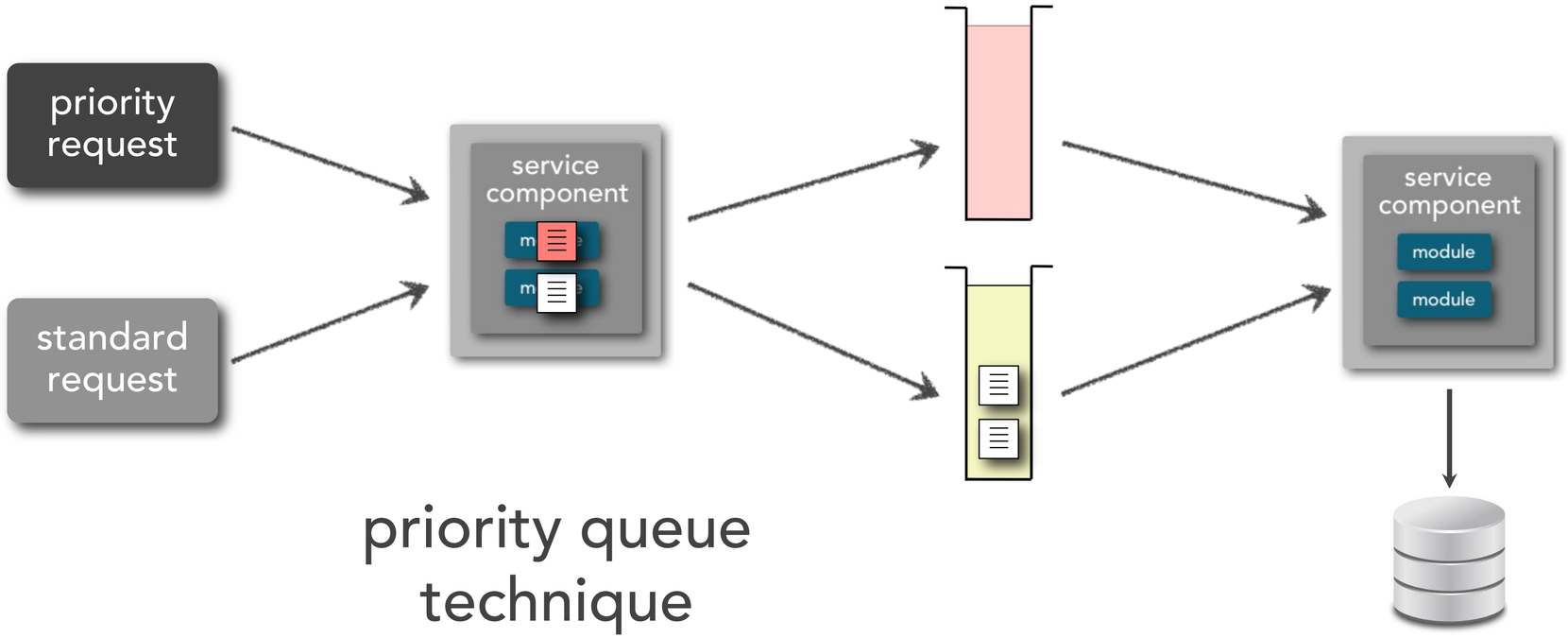
priority queue technique

ambulance pattern



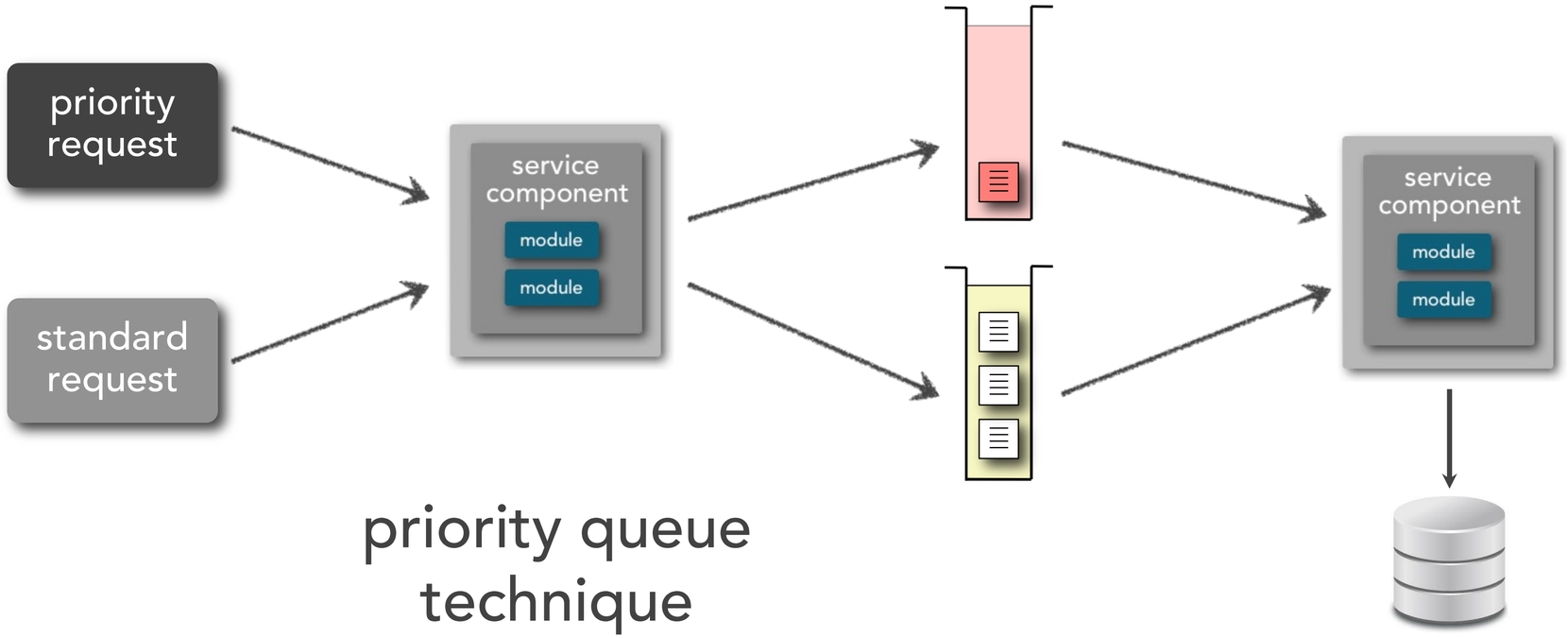
priority queue technique

ambulance pattern



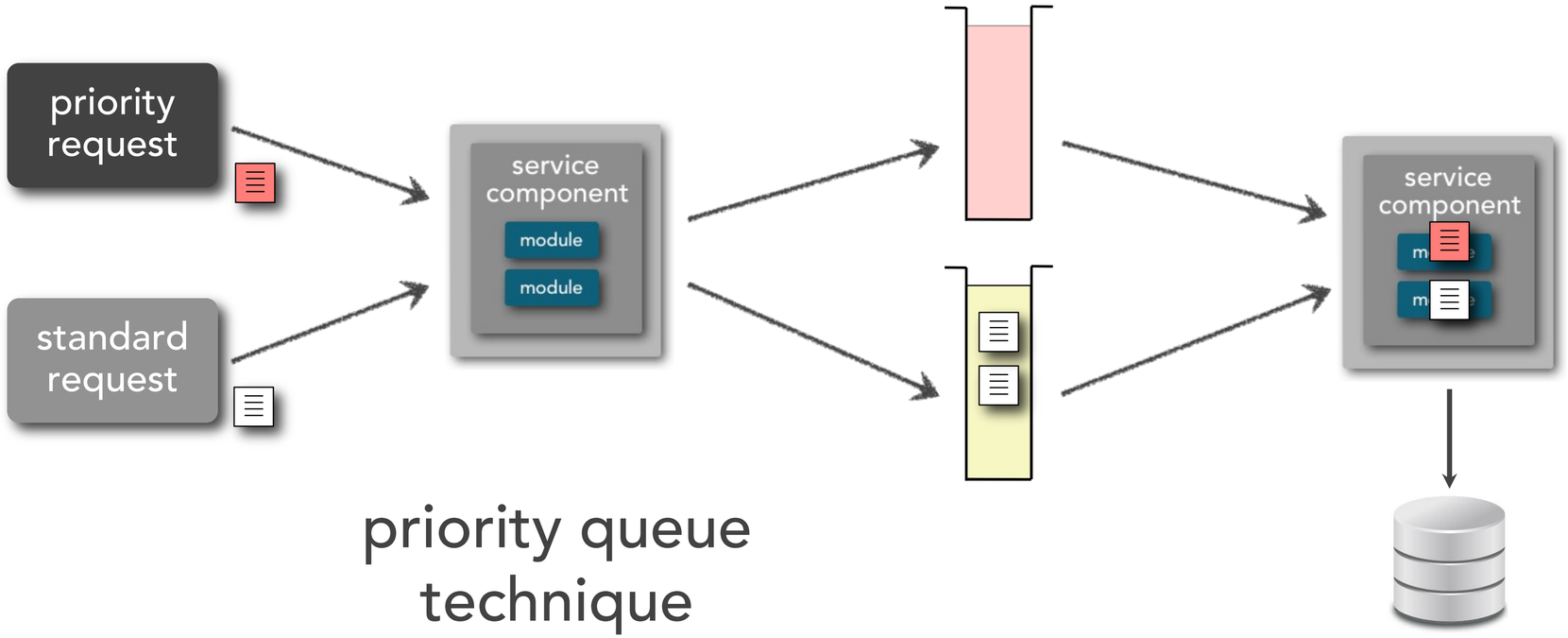
priority queue technique

ambulance pattern



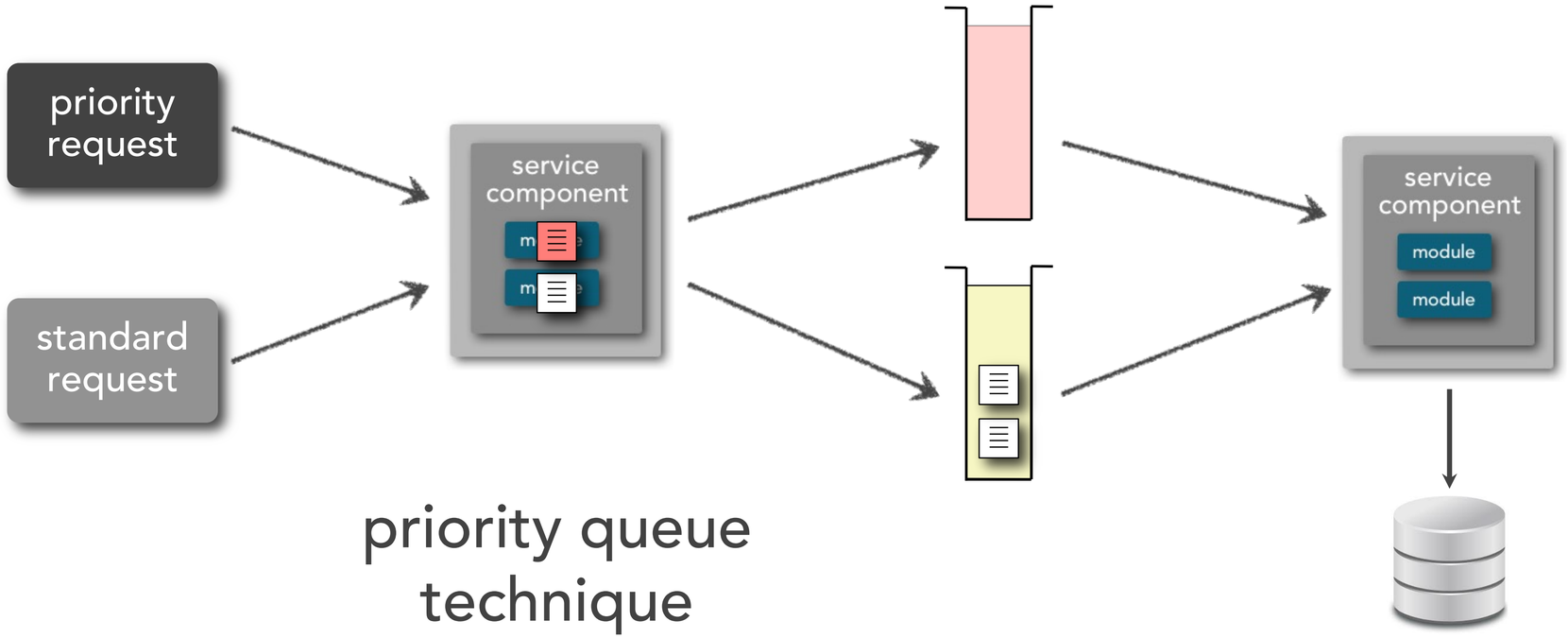
priority queue technique

ambulance pattern



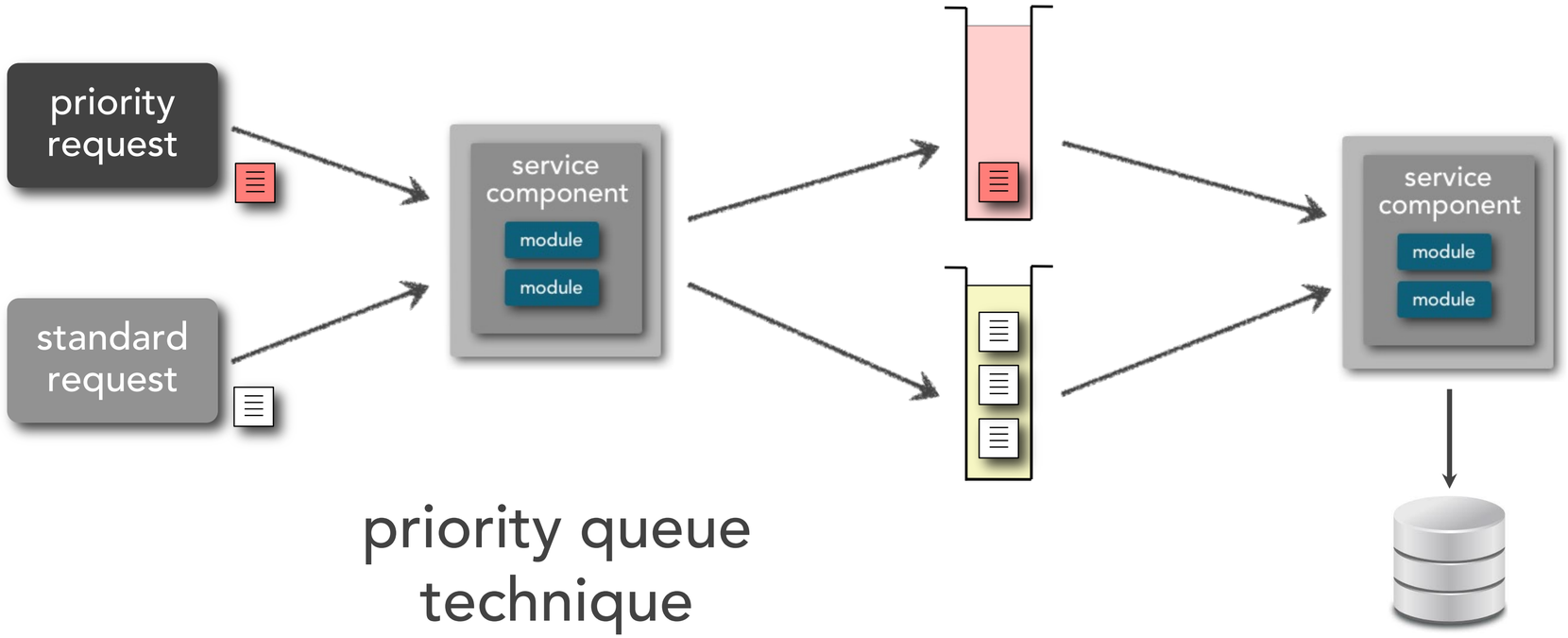
priority queue technique

ambulance pattern



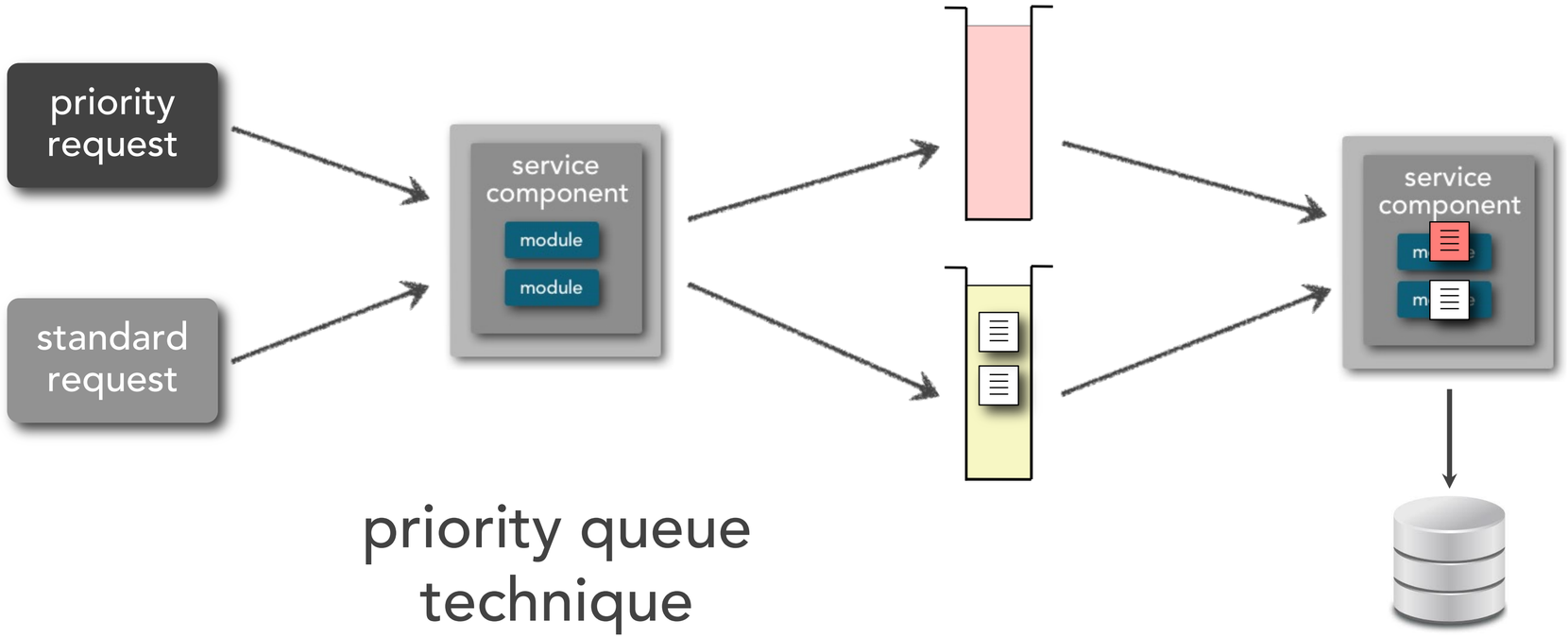
priority queue technique

ambulance pattern



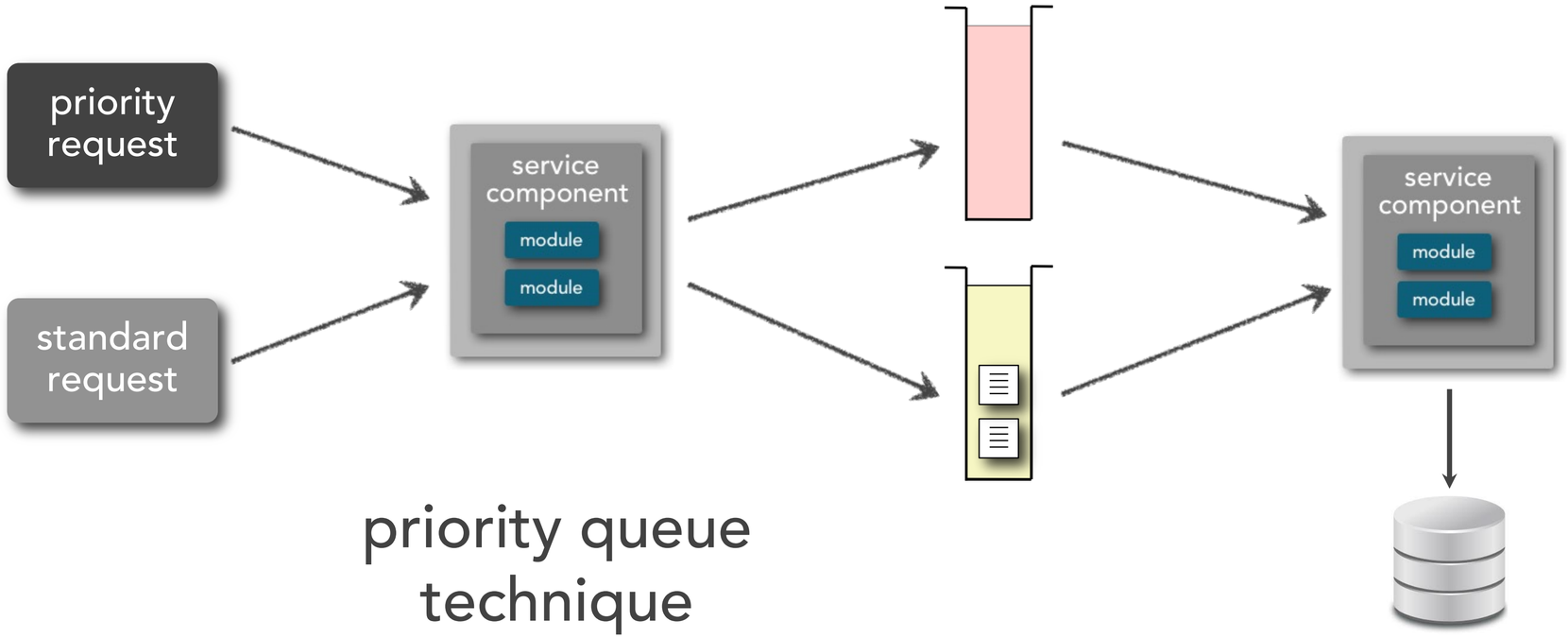
priority queue technique

ambulance pattern



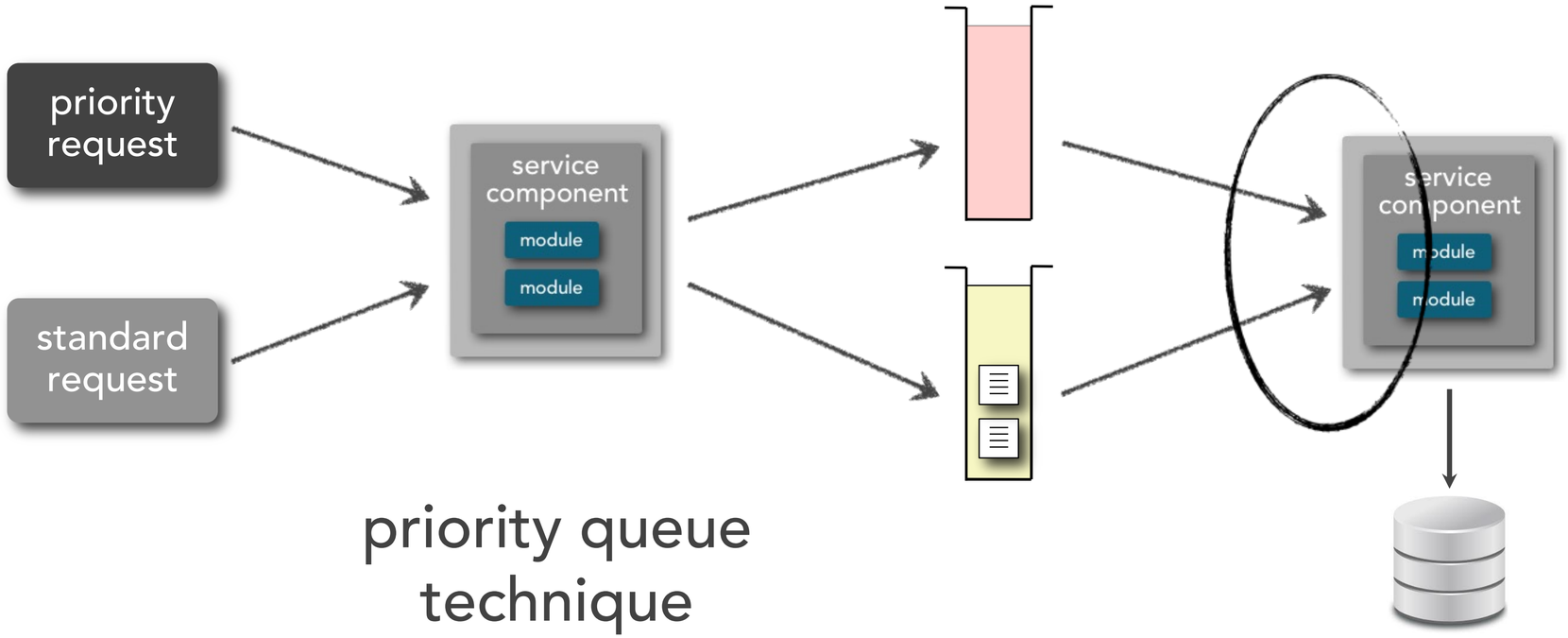
priority queue technique

ambulance pattern



priority queue technique

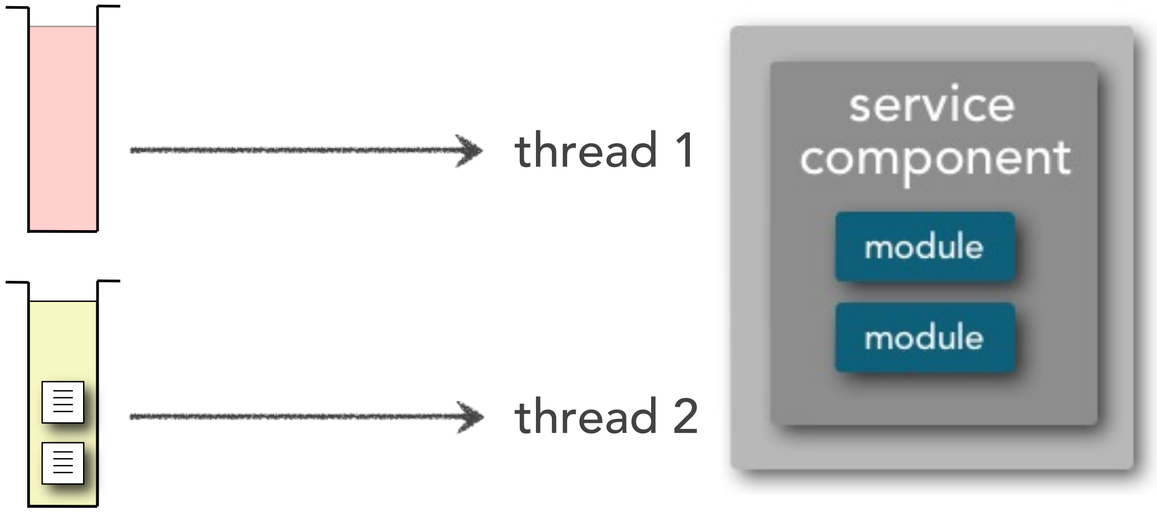
ambulance pattern



priority queue technique

ambulance pattern

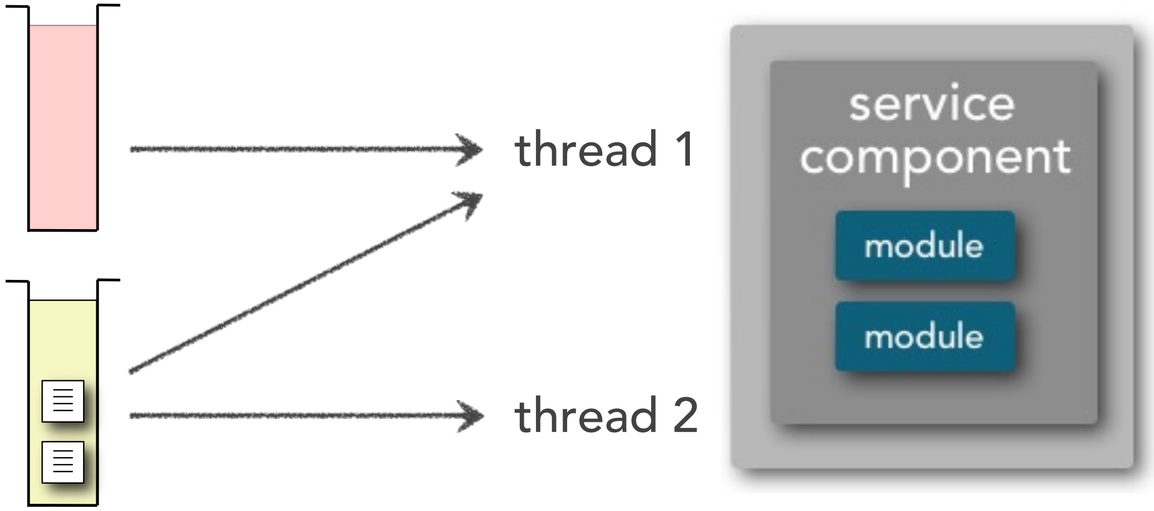
carpool vs. ambulance



carpool - thread 1 is dedicated to priority messages only and remains idle if no priority messages exist

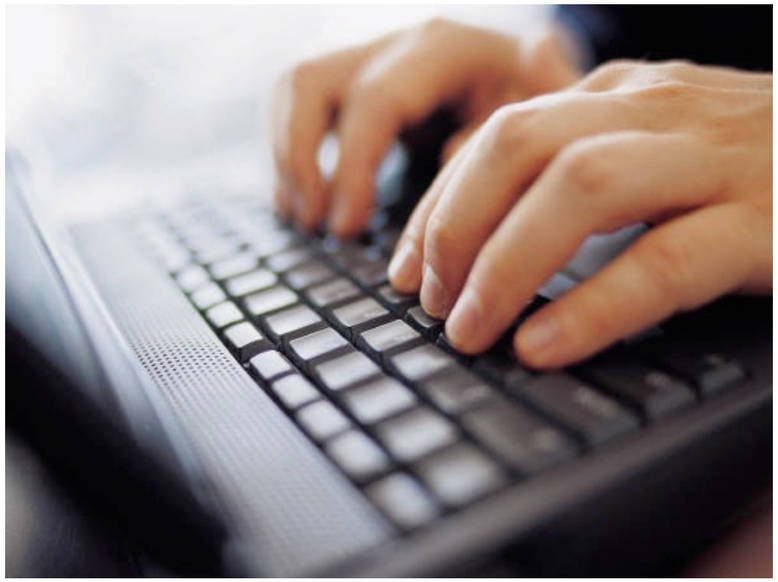
ambulance pattern

carpool vs. ambulance



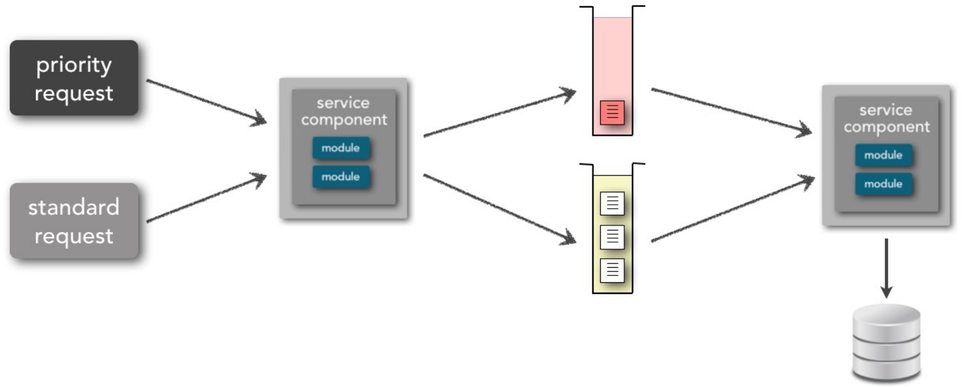
ambulance - thread 1 can handle standard requests as well, but always checks priority queue first before getting the next standard message

ambulance pattern

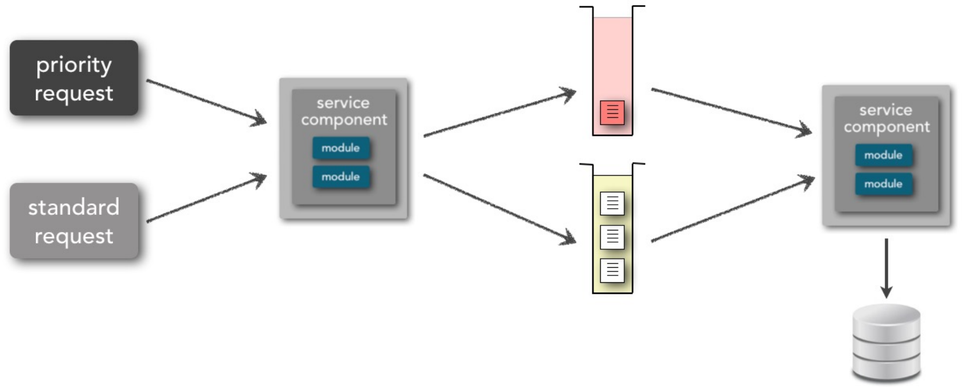


let’s apply the pattern…

ambulance pattern



ambulance pattern

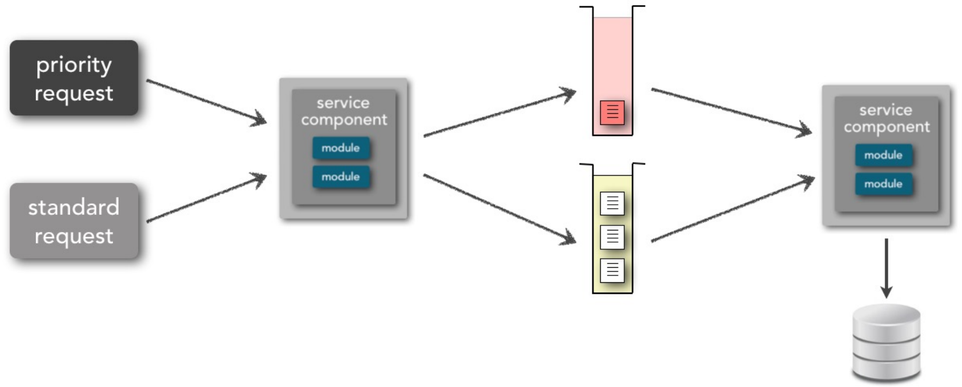


message priority

throughput

performance

ambulance pattern



message priority

throughput

performance

complexity

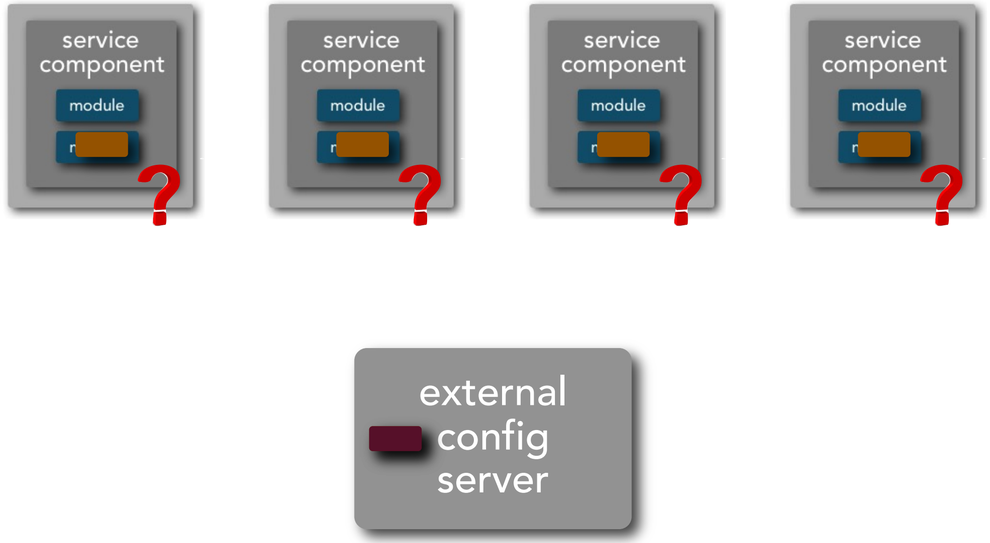
Watch Notification Pattern

watch notification pattern

https://github.com/wmr513/event-driven-patterns/tree/master/watch

watch notification pattern

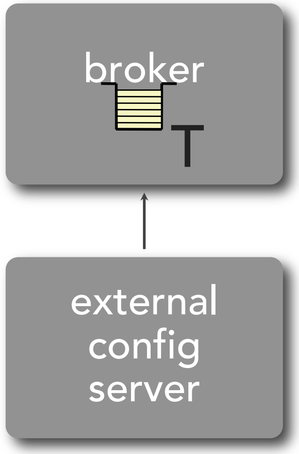
"how can I send notification events to services without maintaining a persistent connection to those services?"



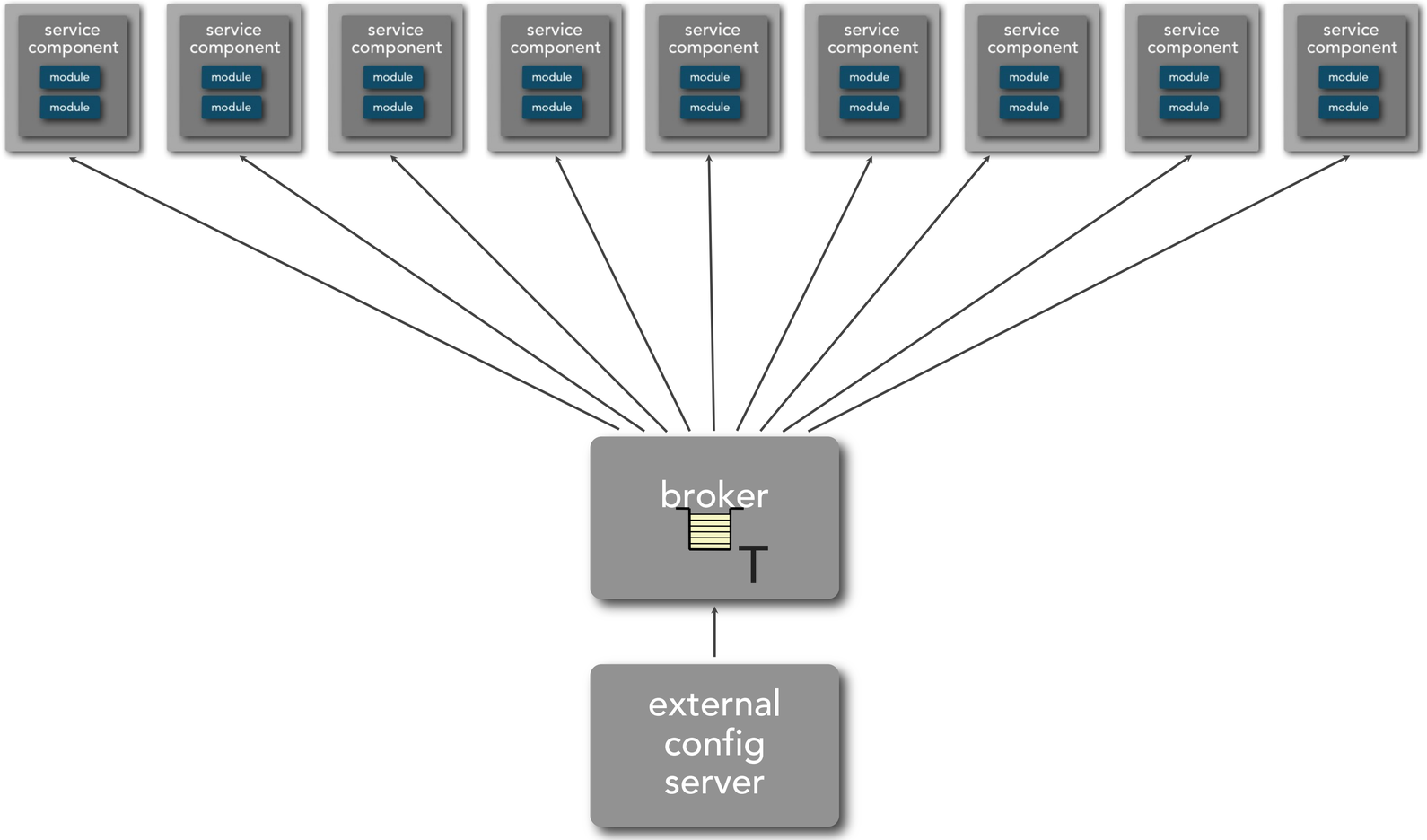
watch notification pattern

external config server

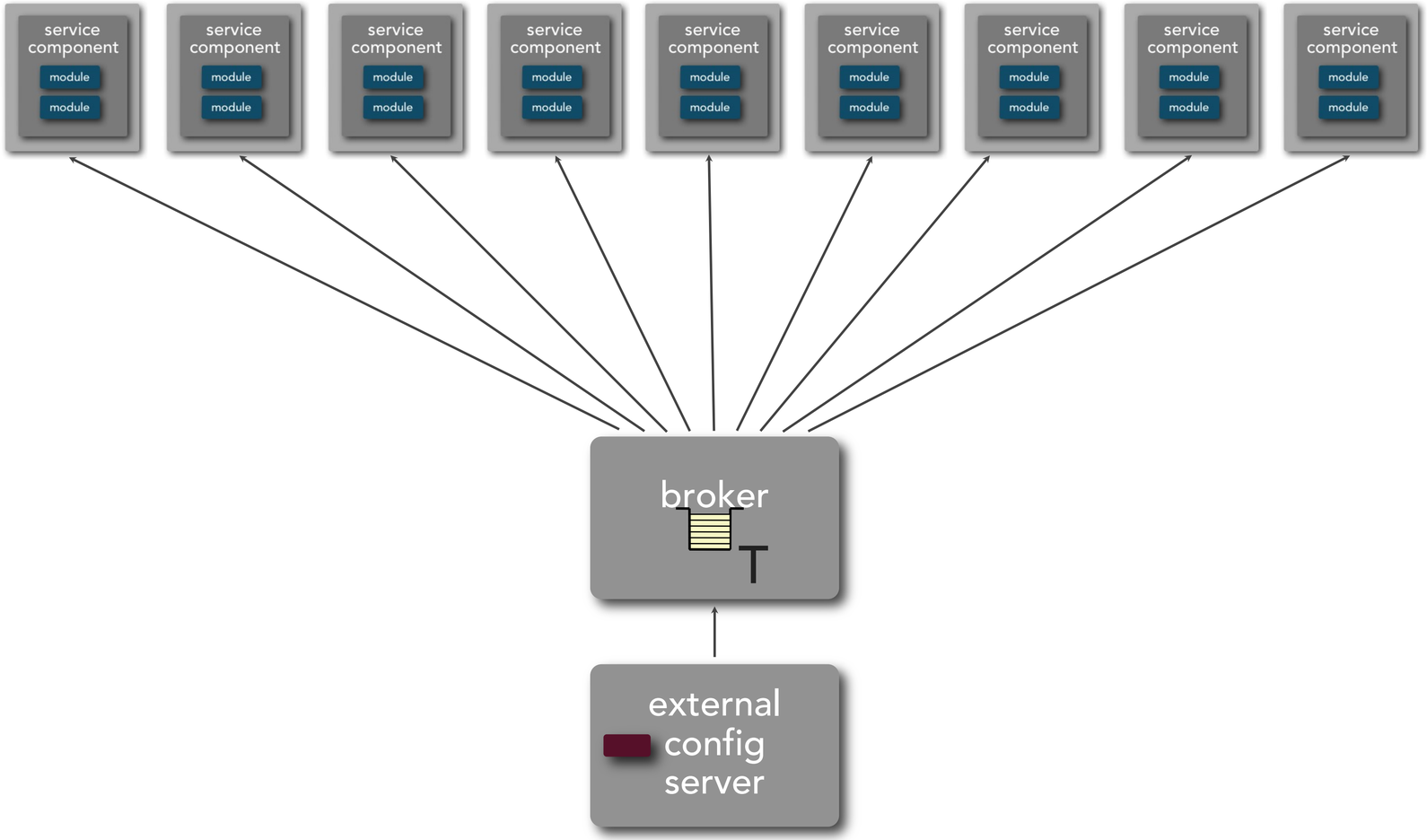
watch notification pattern



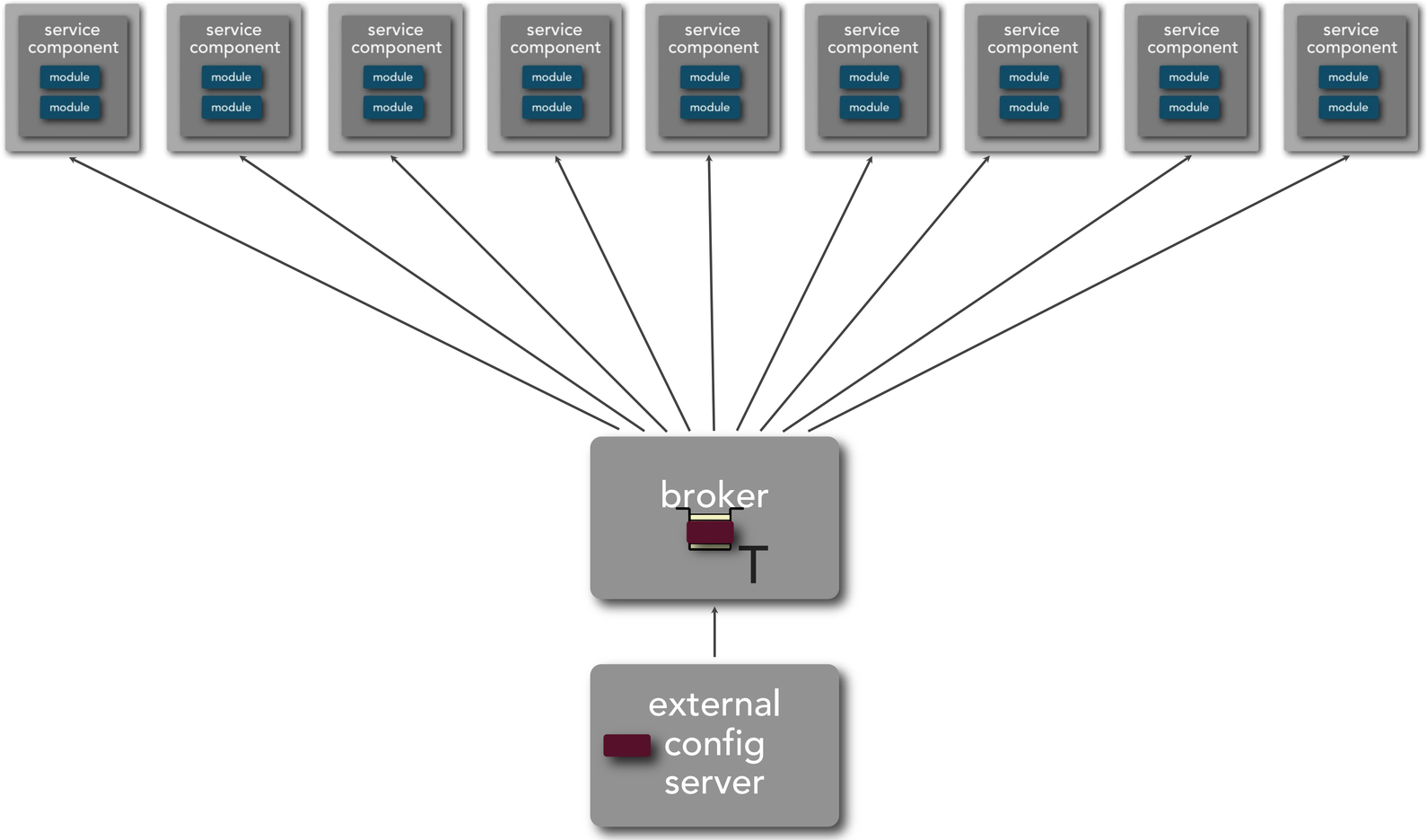
watch notification pattern



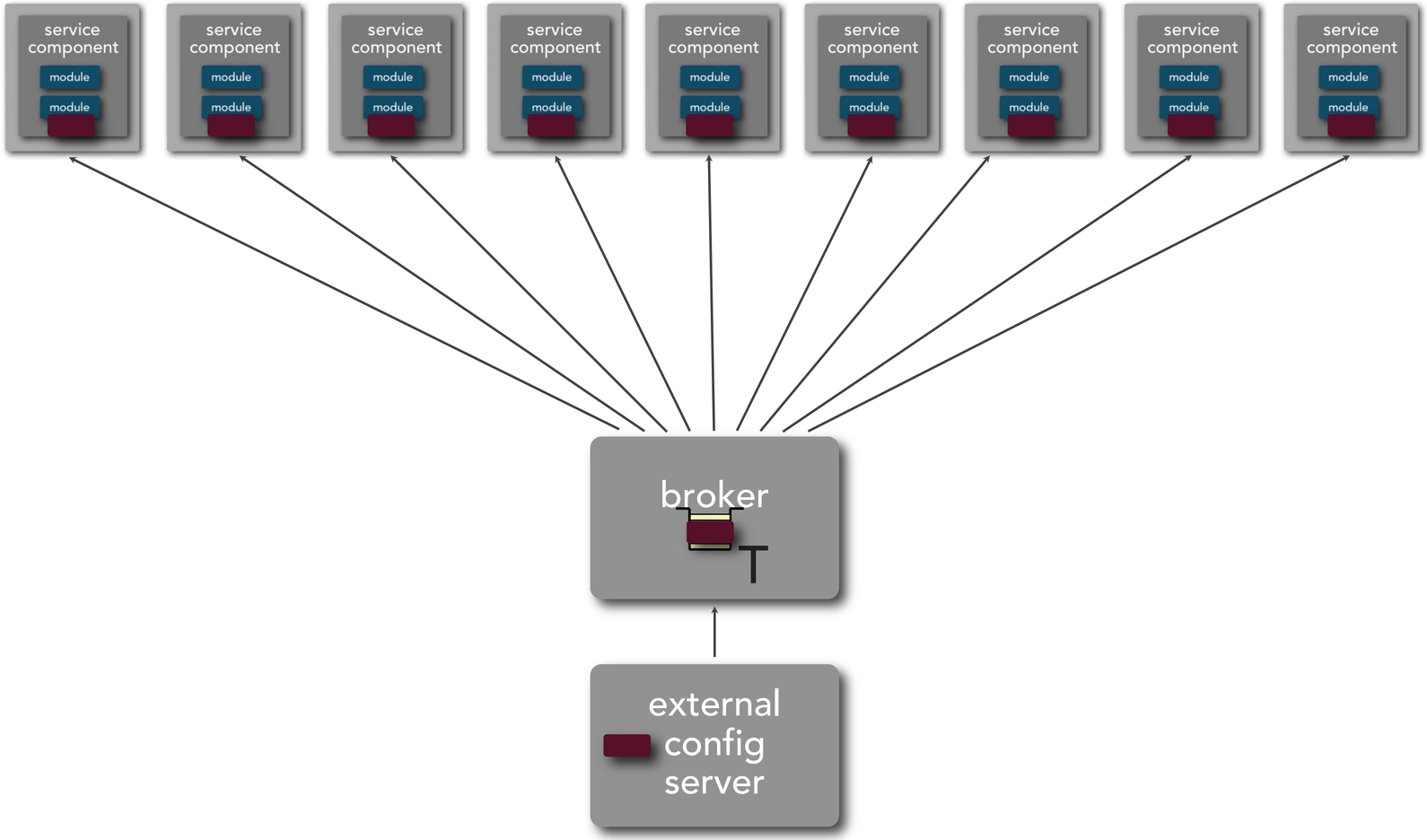
watch notification pattern



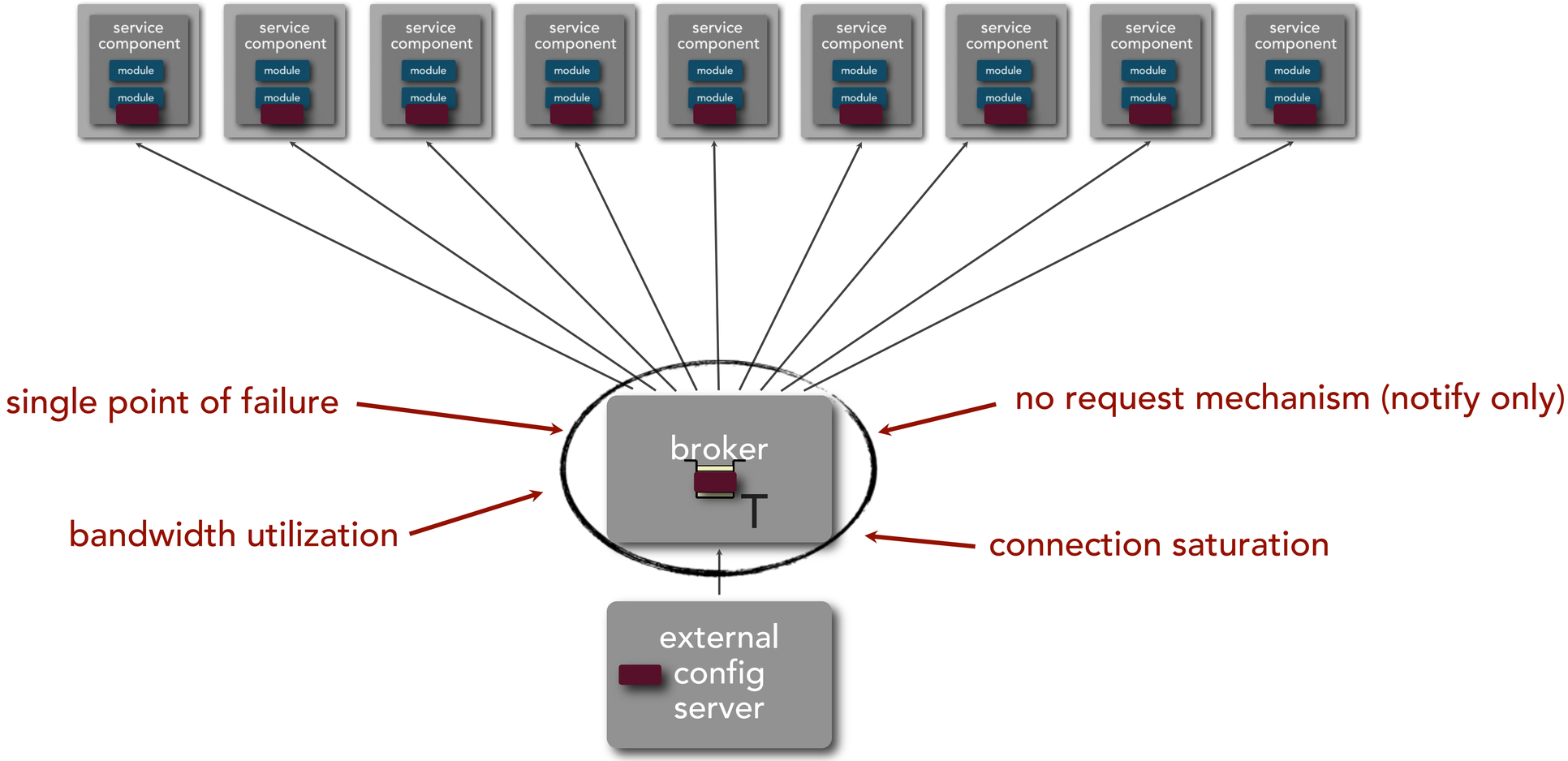
watch notification pattern



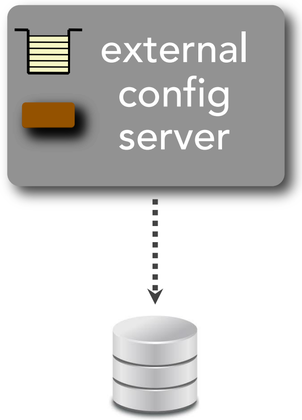
watch notification pattern



watch notification pattern

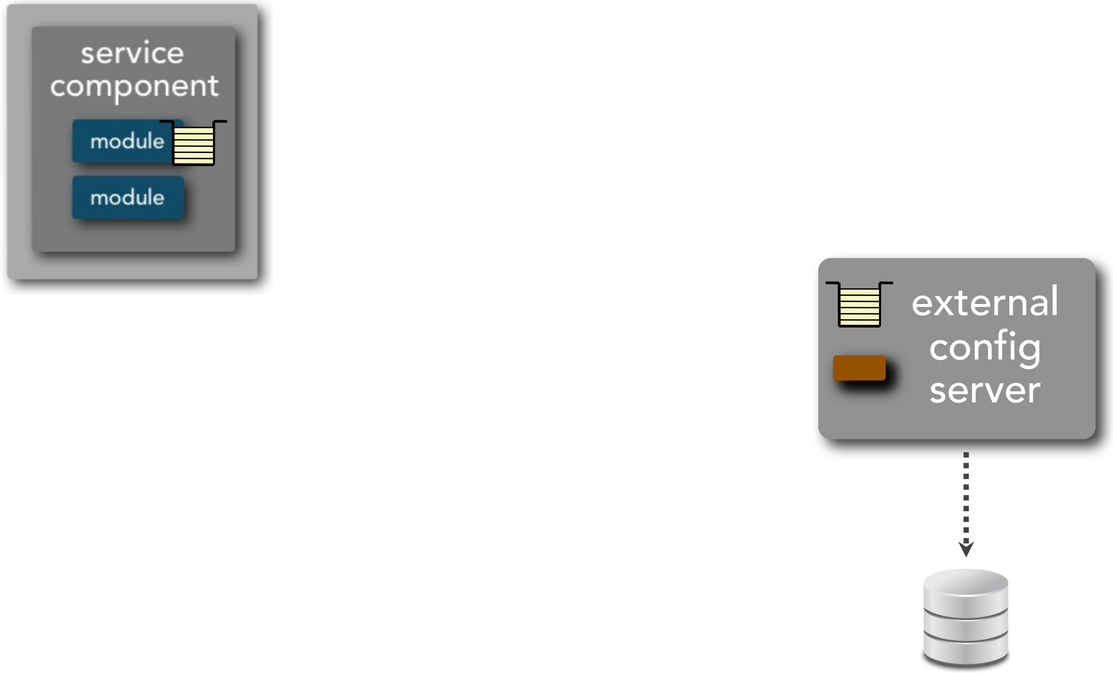


watch notification pattern



watch notification pattern

svc1:62880/watch_q



watch notification pattern

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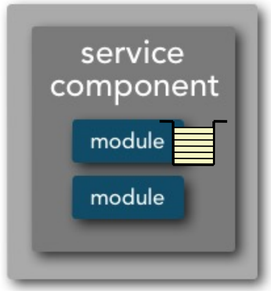

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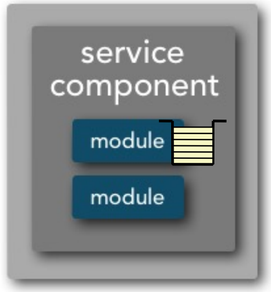
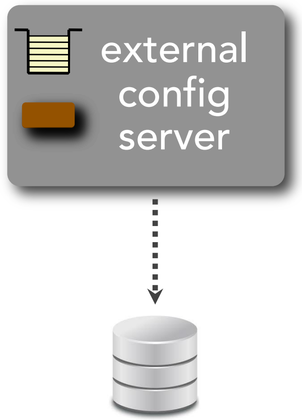
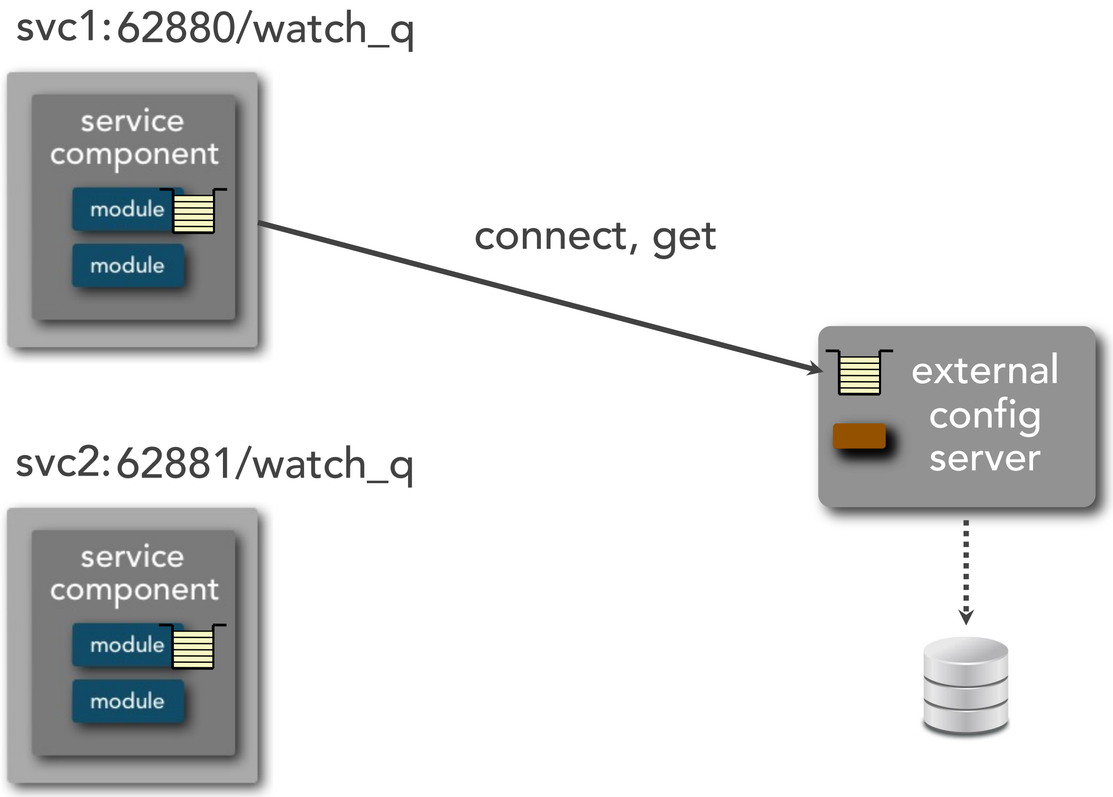




watch notification pattern



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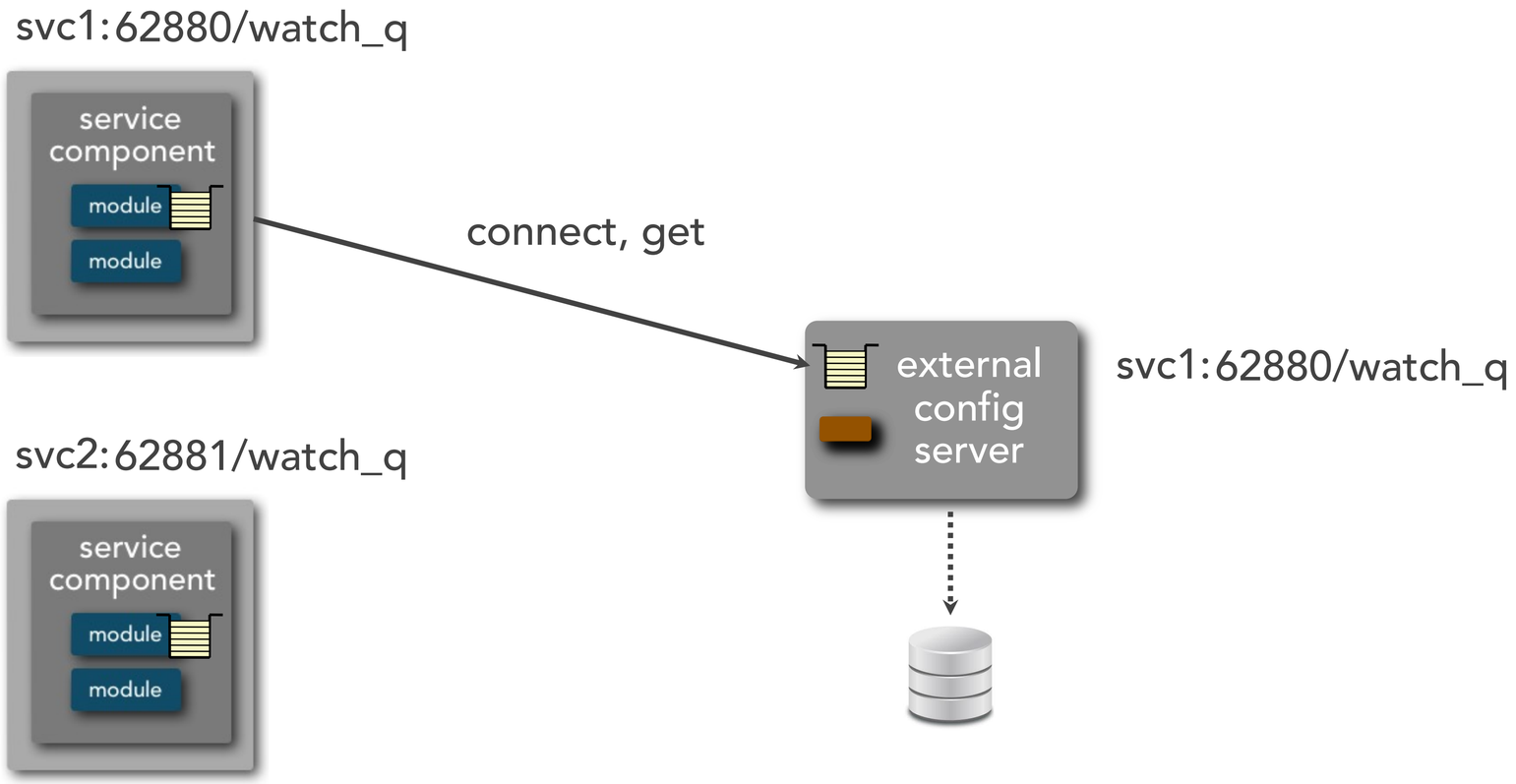
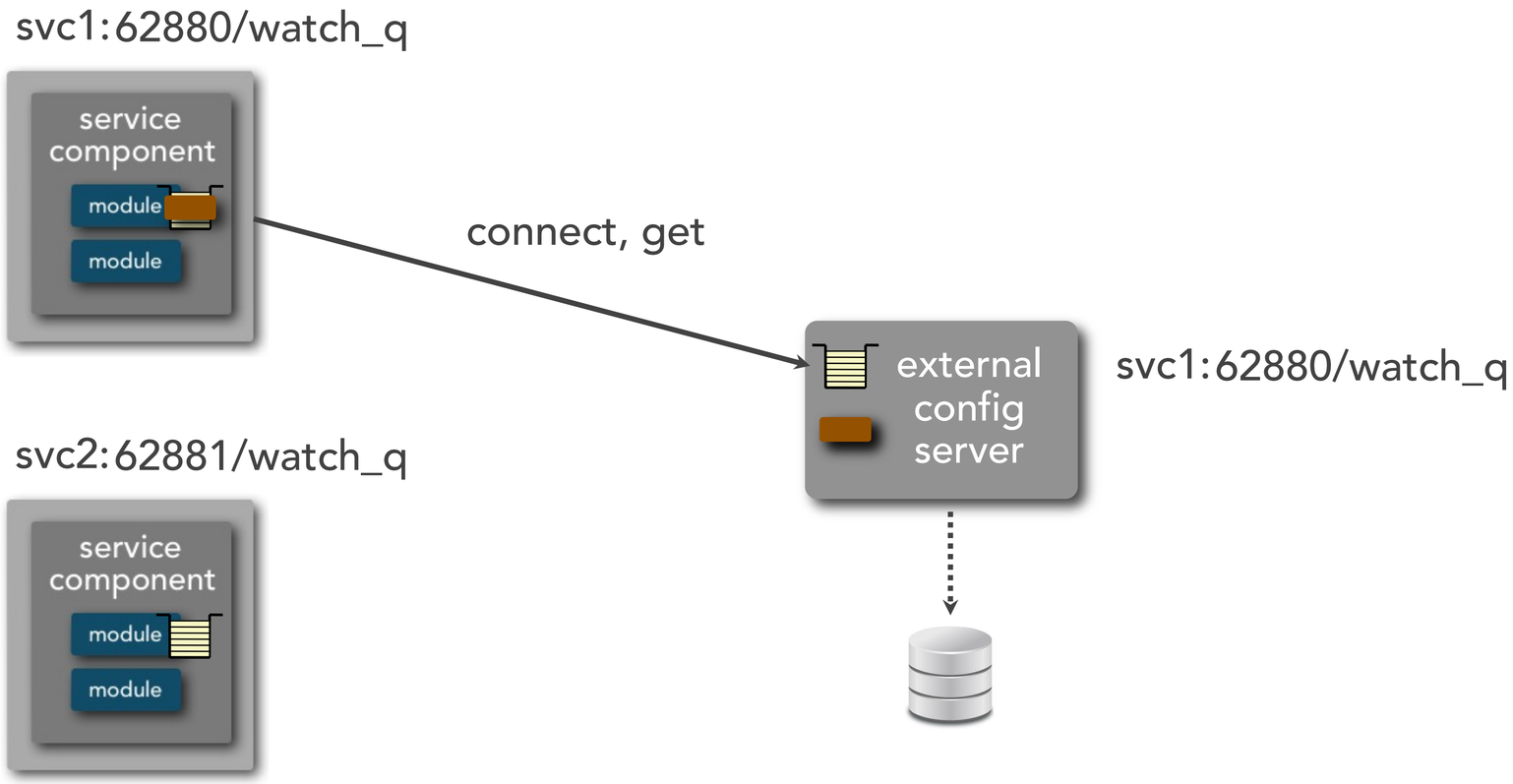
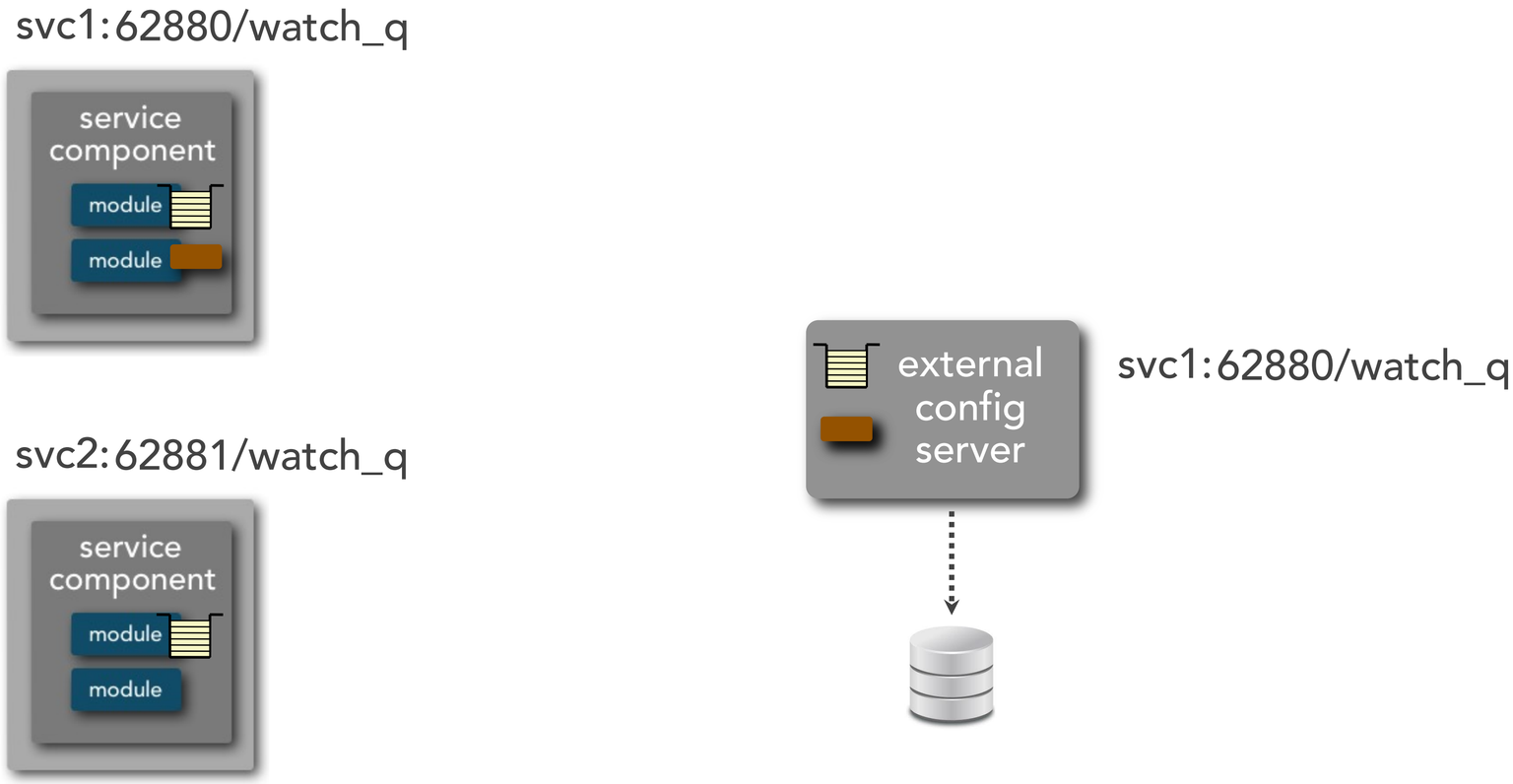


watch notification pattern



watch notification pattern



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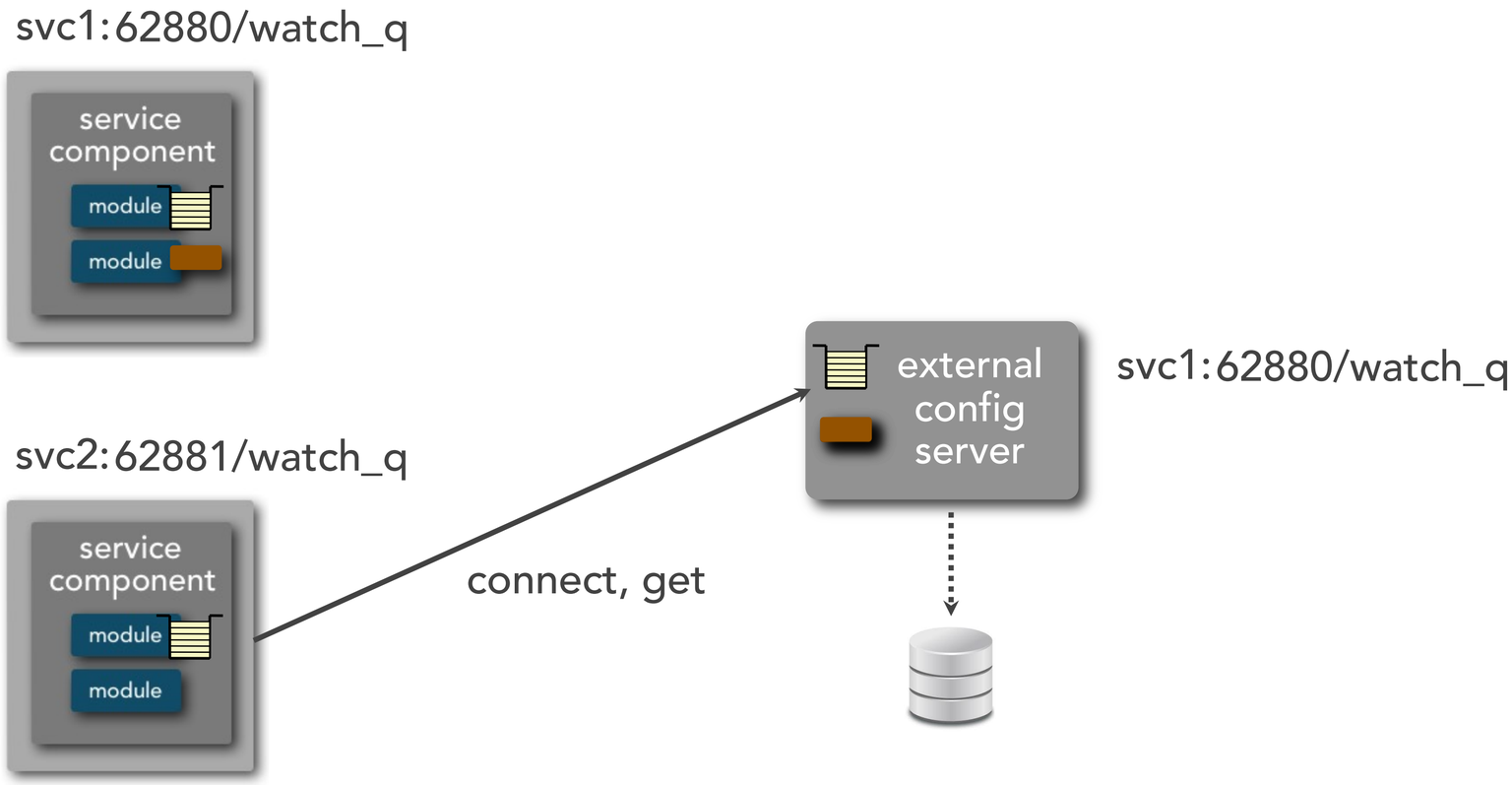

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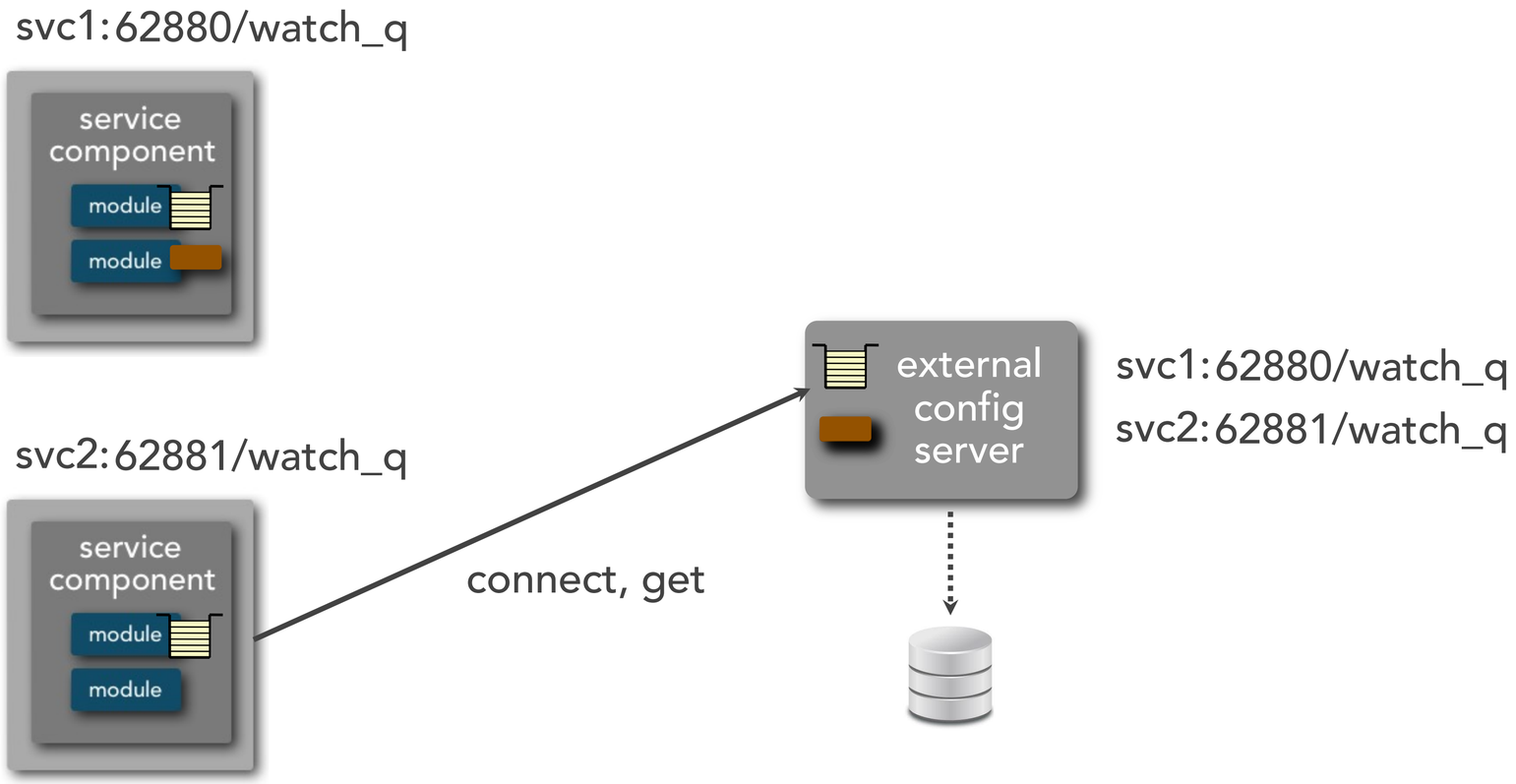

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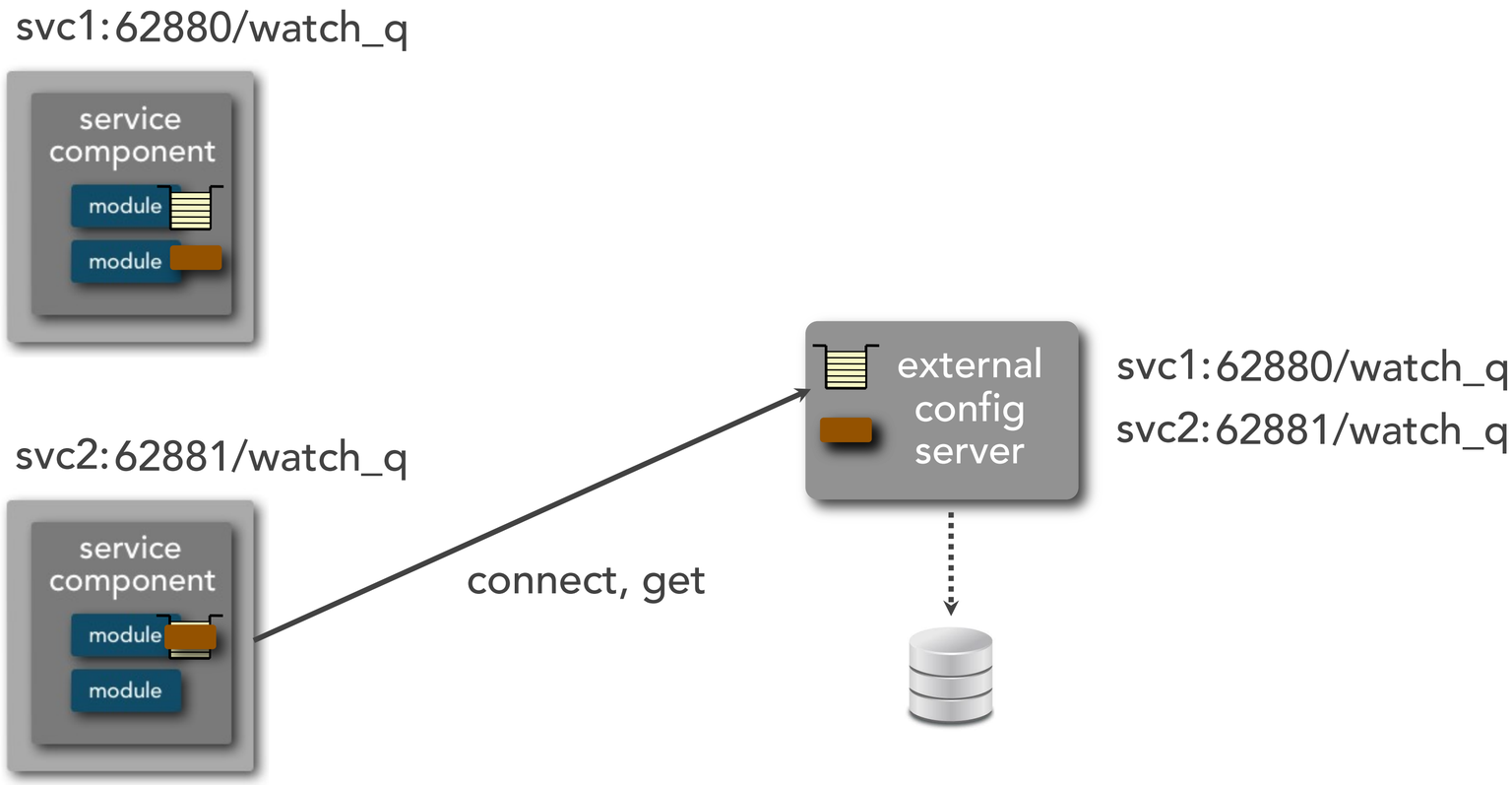

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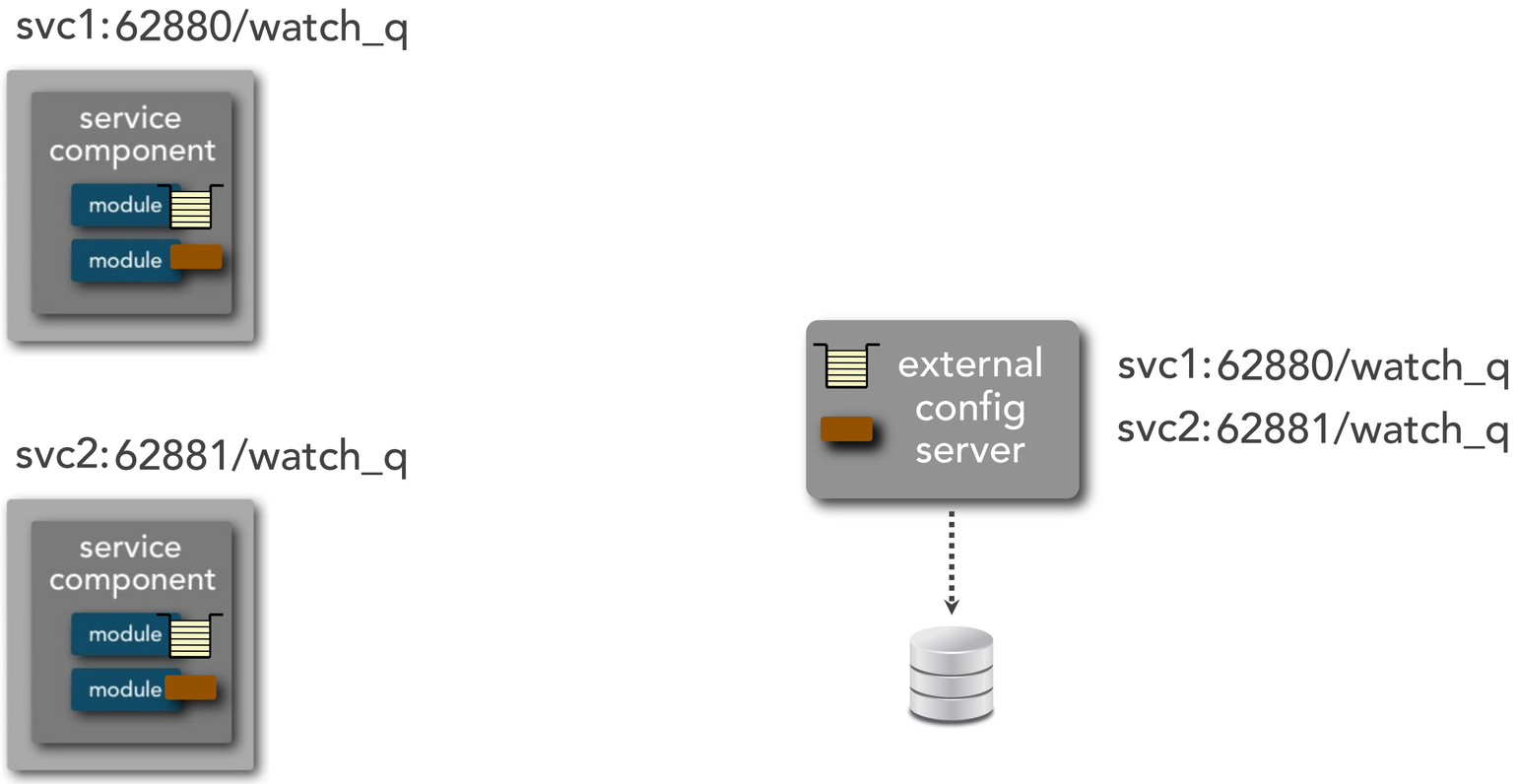
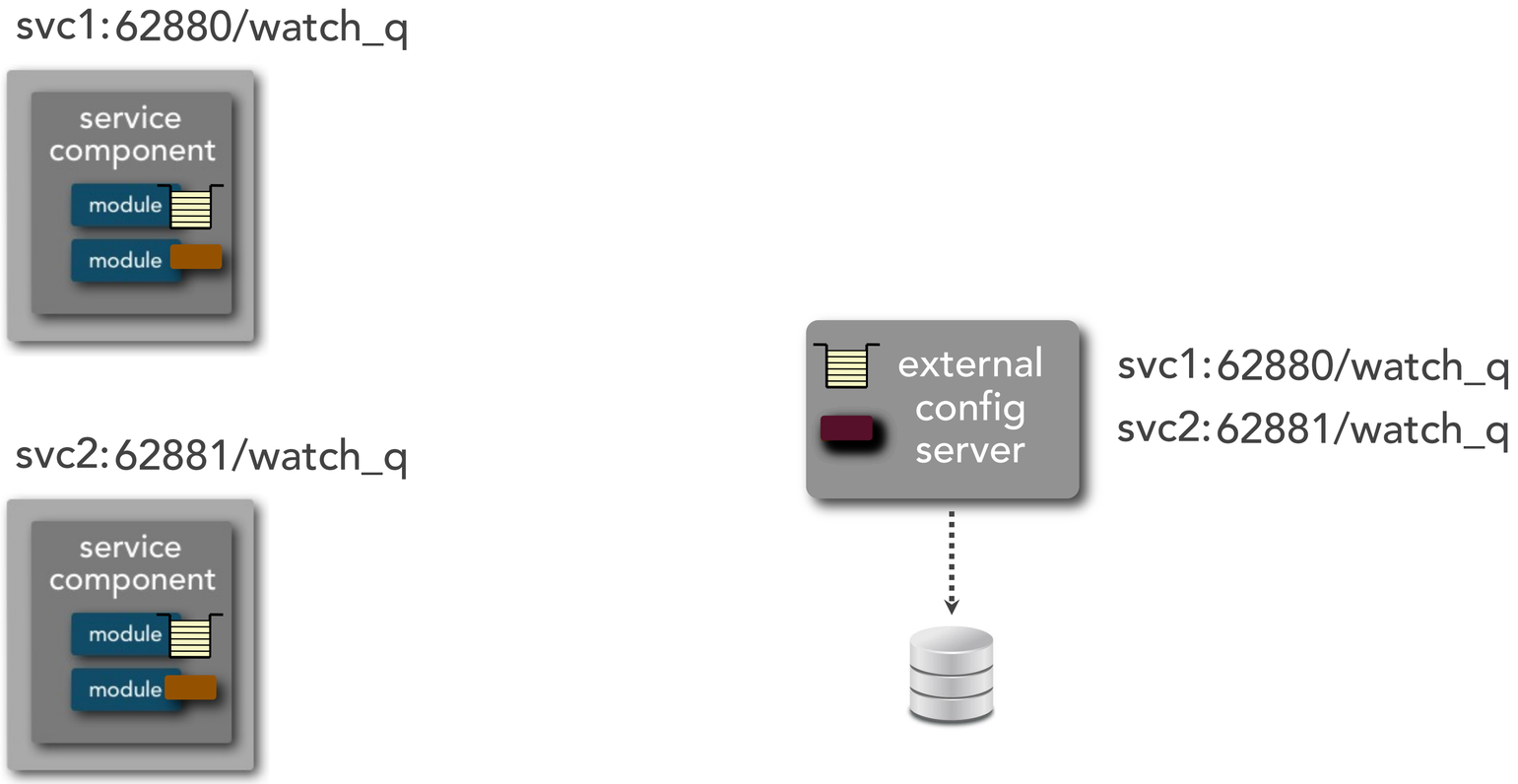
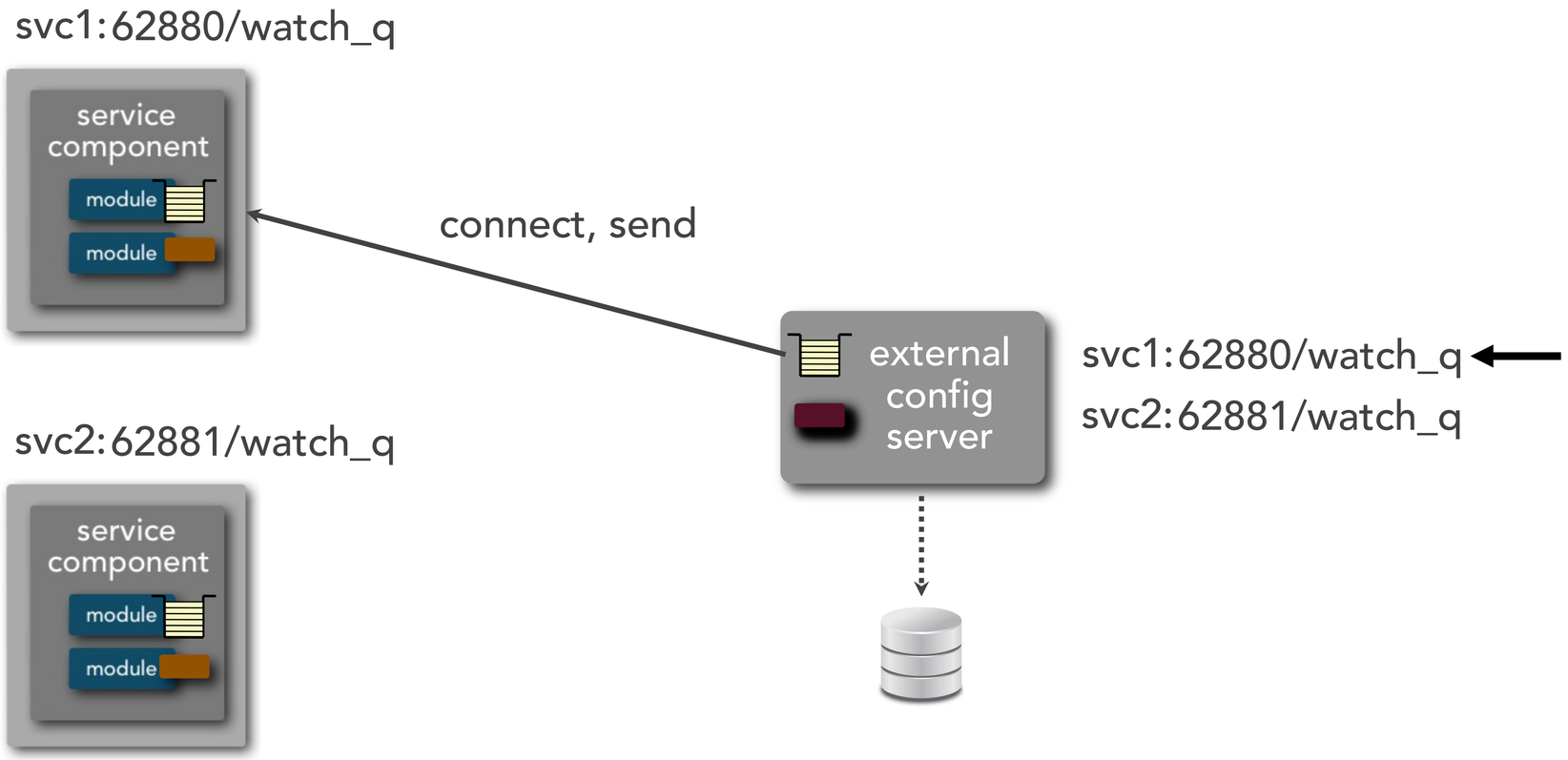


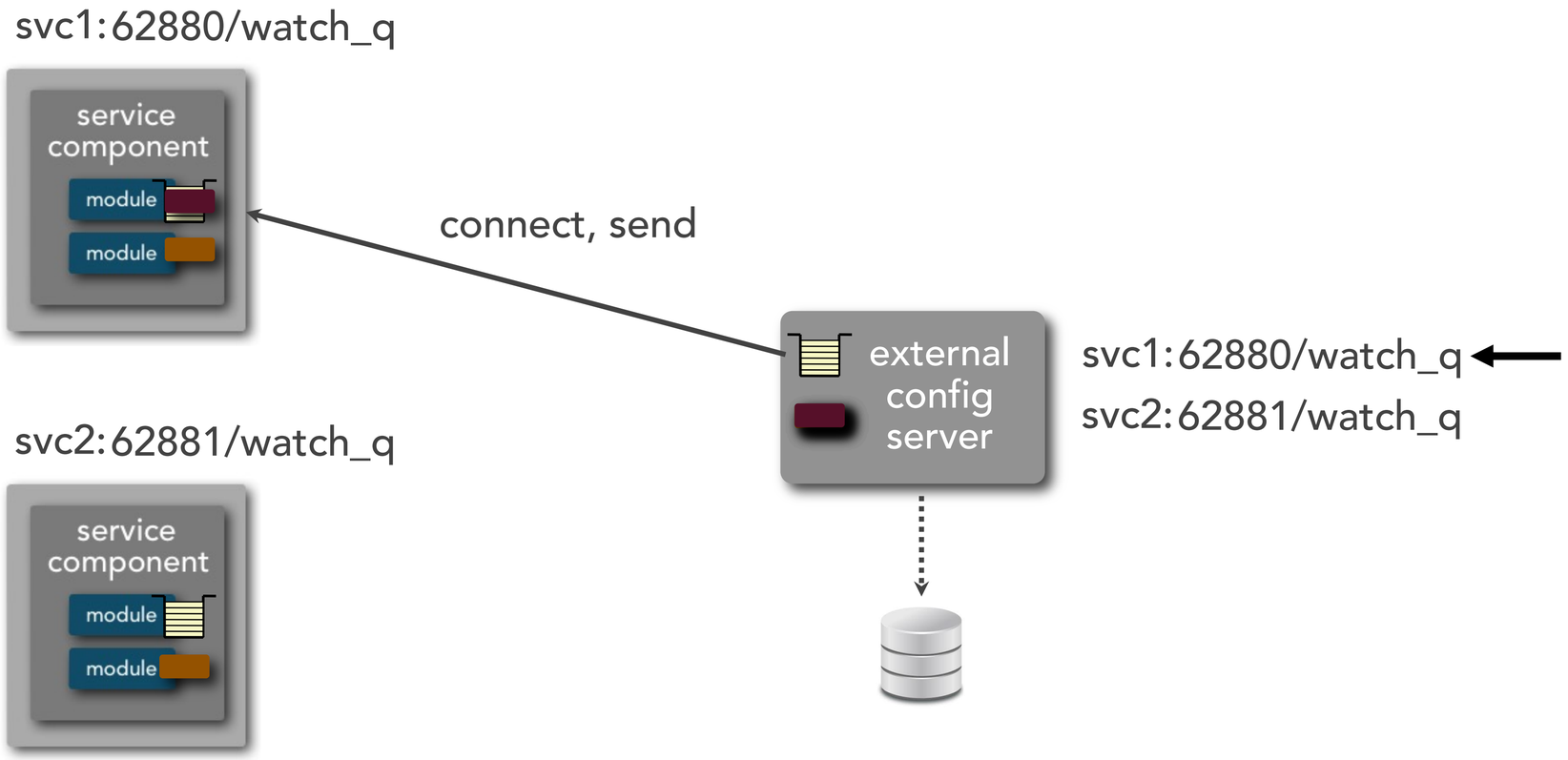
watch notification pattern



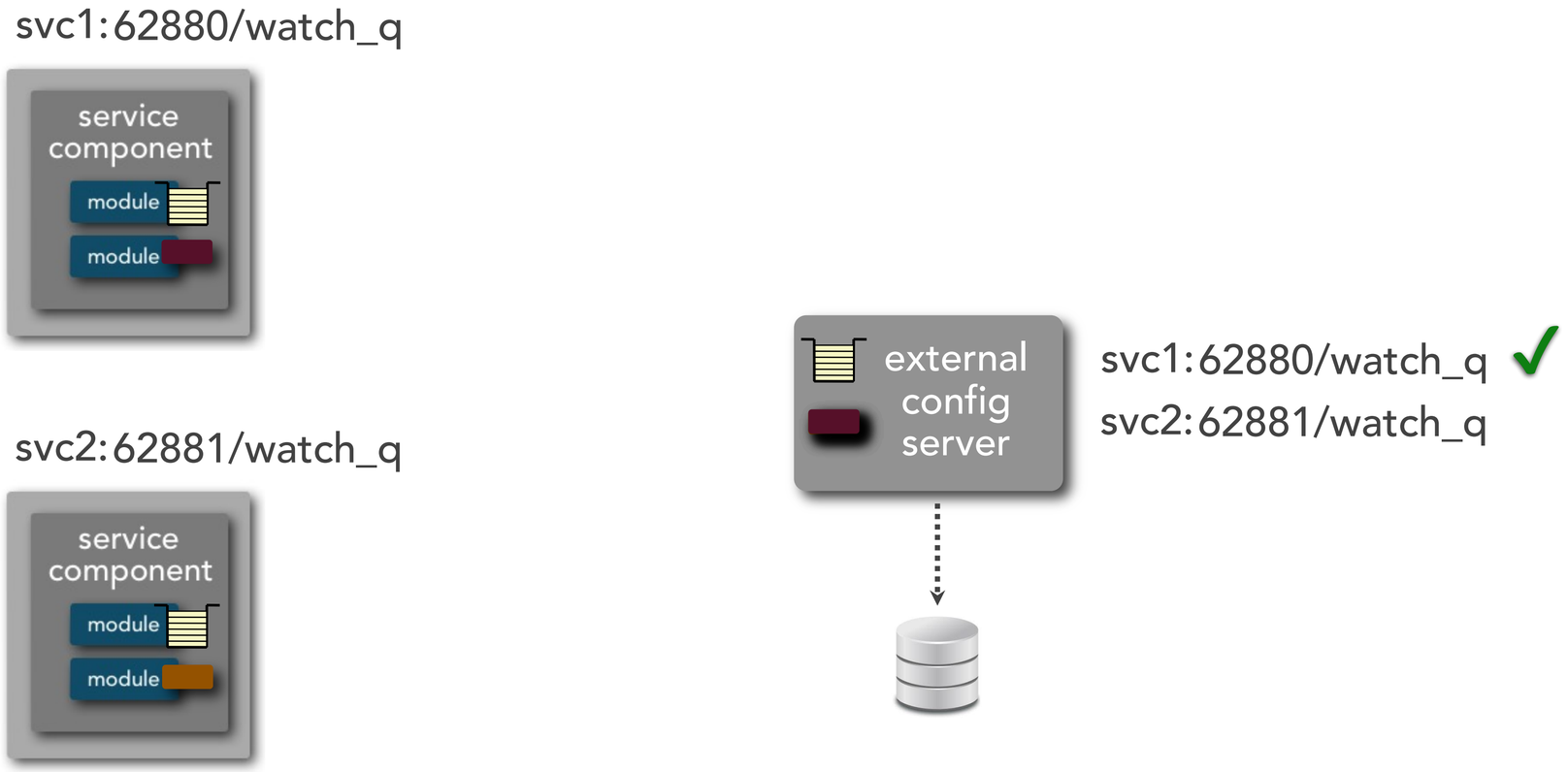
watch notification pattern



watch notification pattern



watch notification pattern



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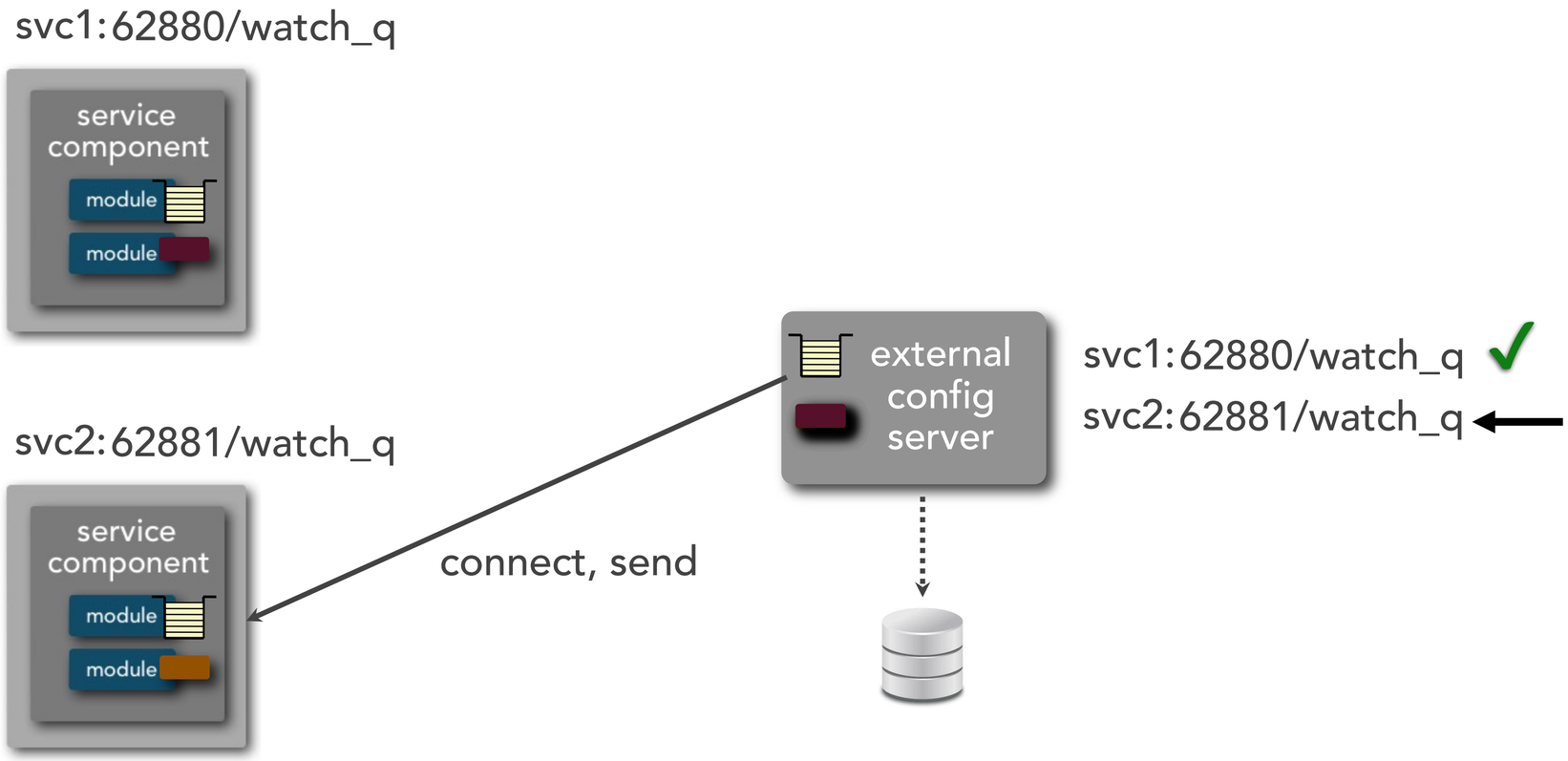

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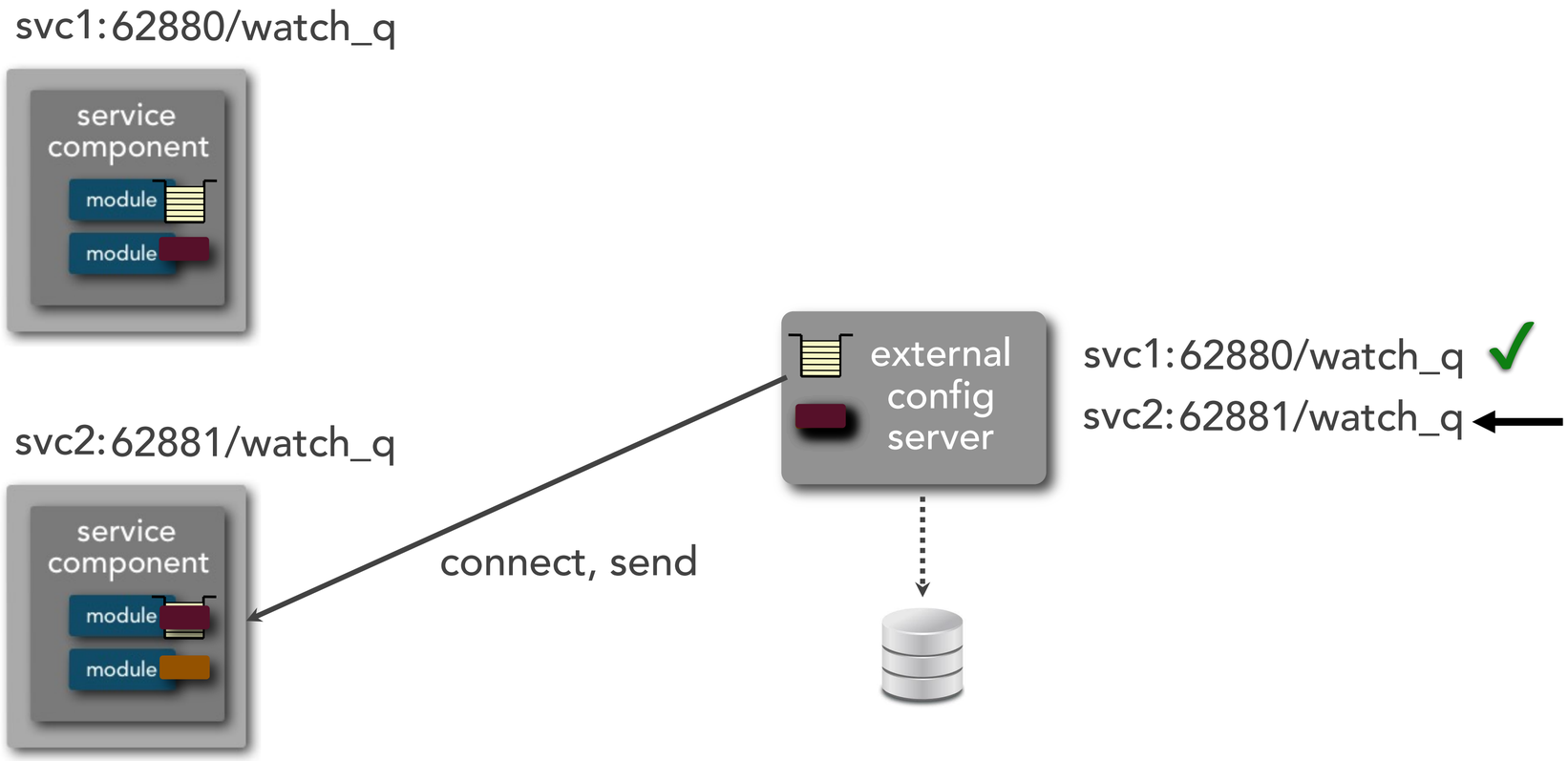

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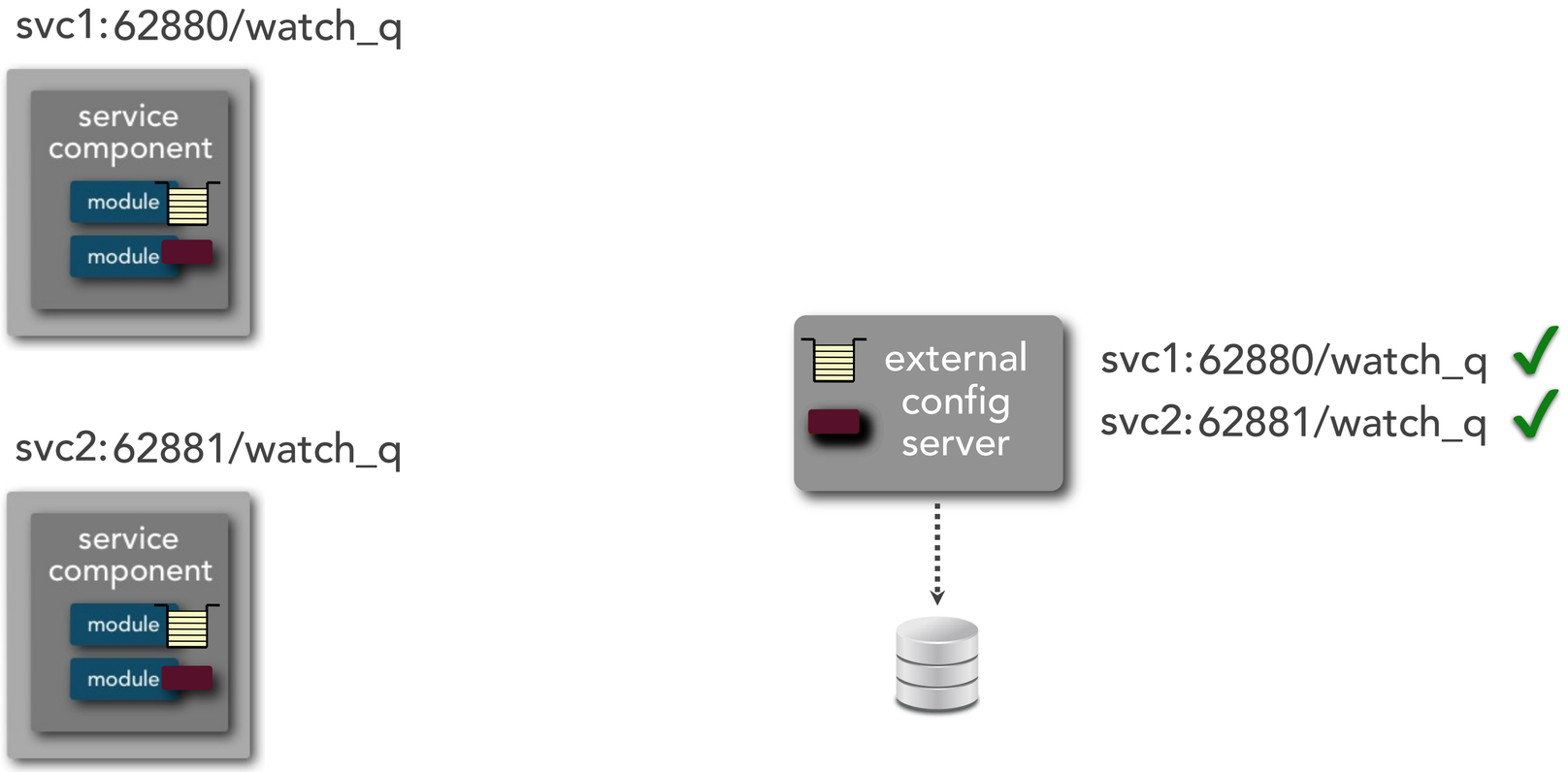

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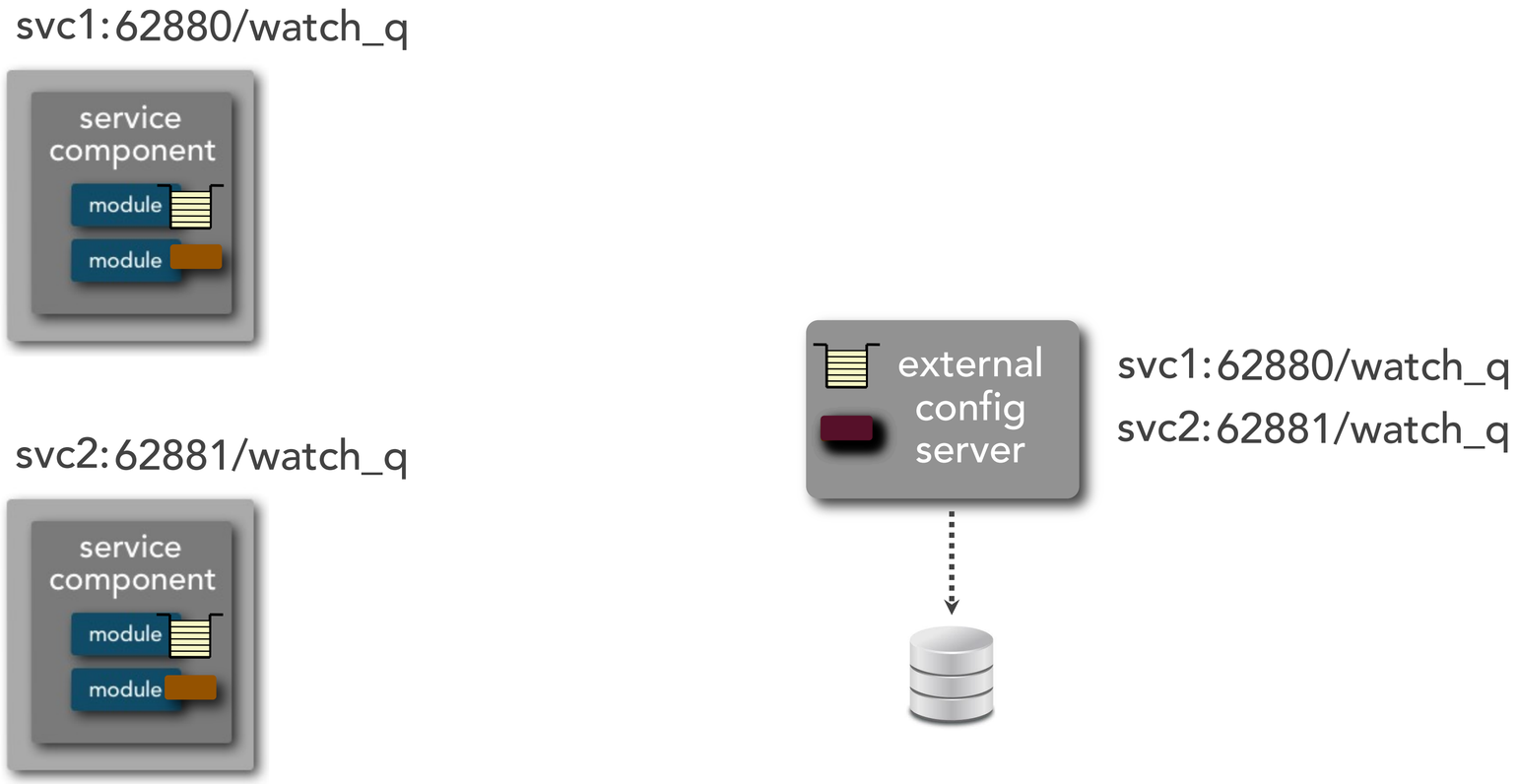

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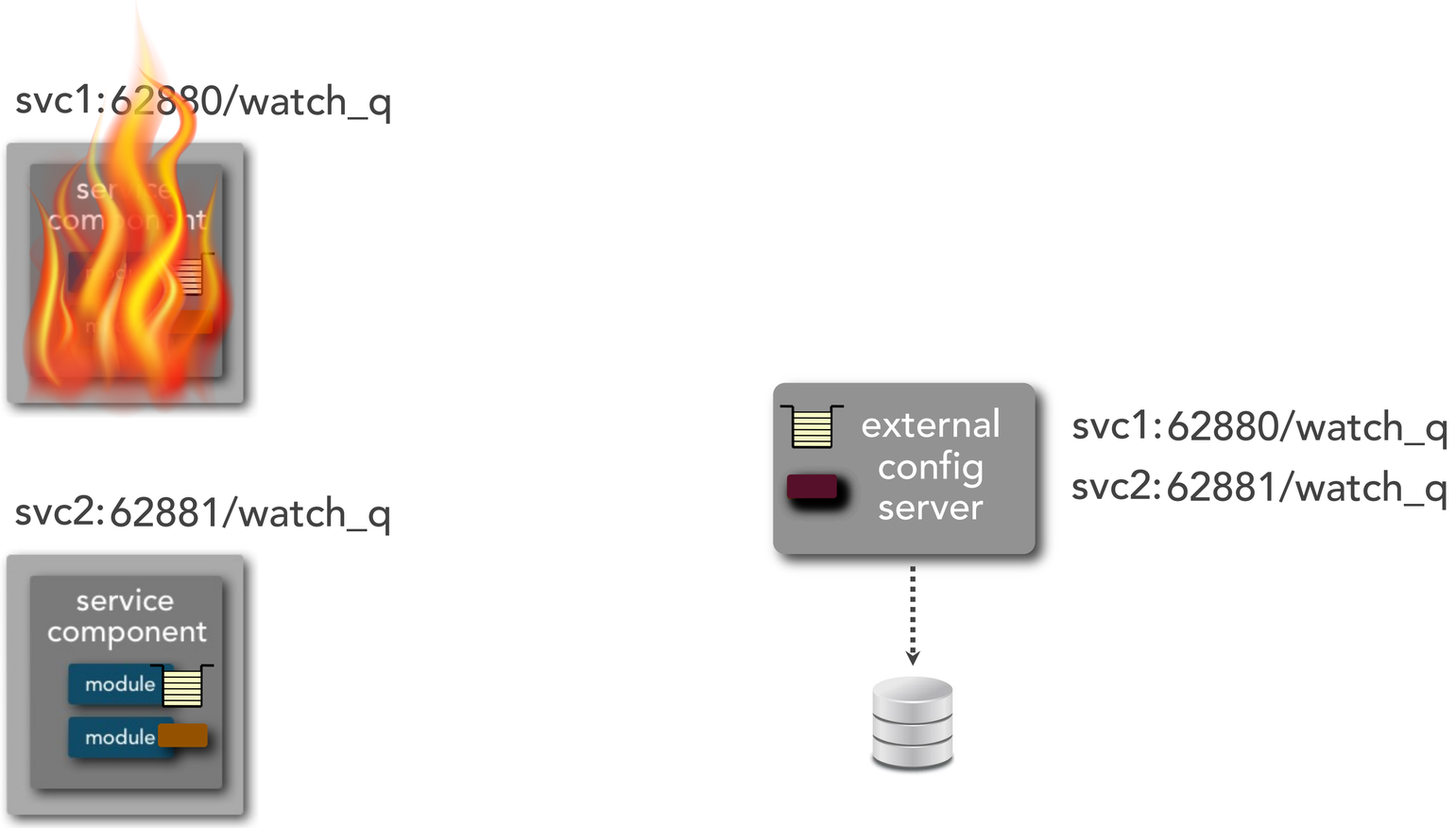

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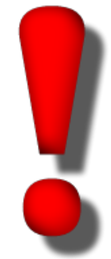
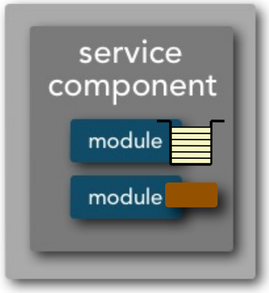
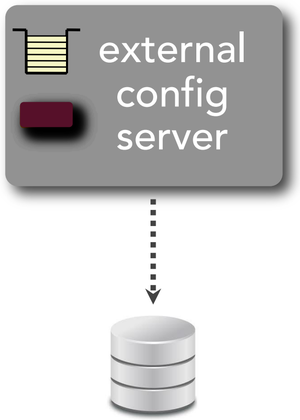


svc2:62881/watch_q





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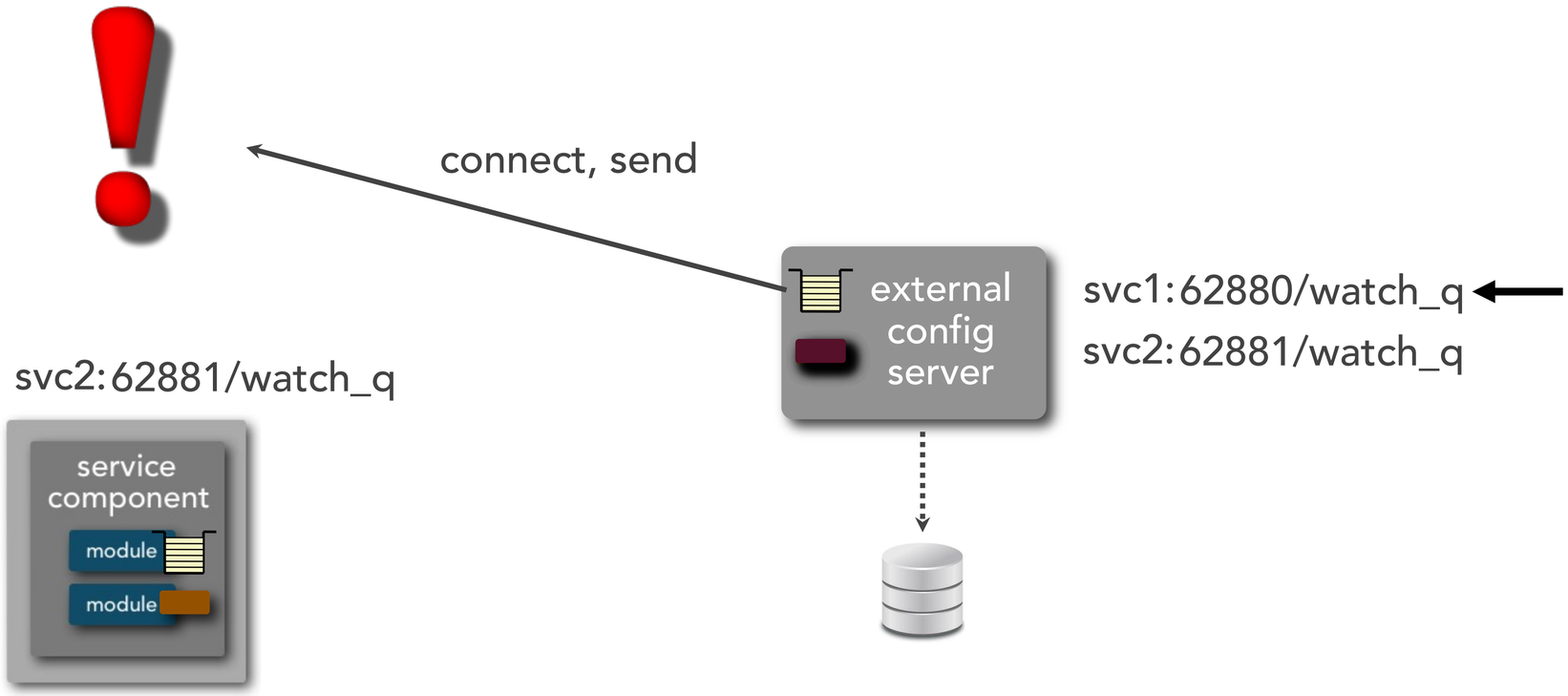
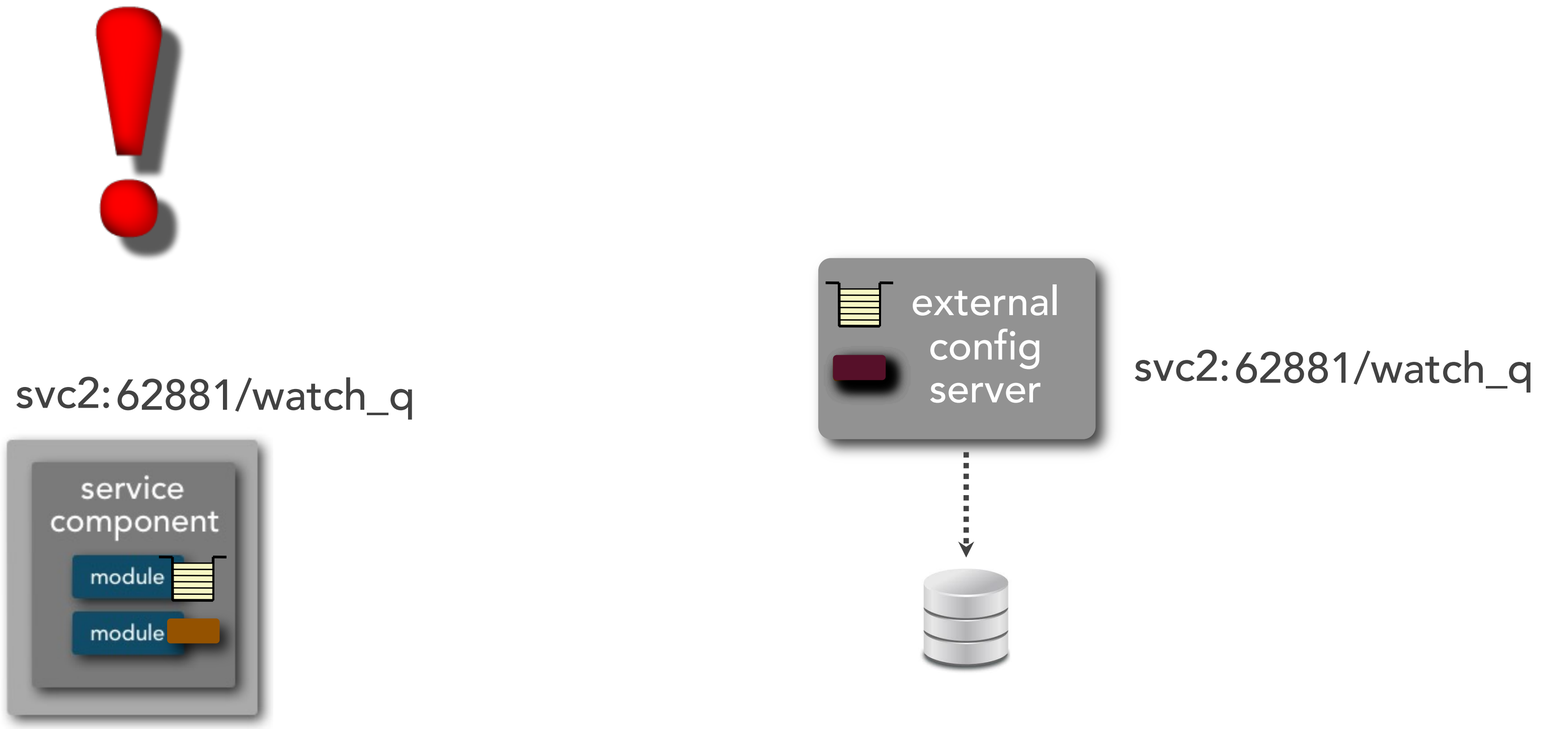
svc2:62881/watch_q

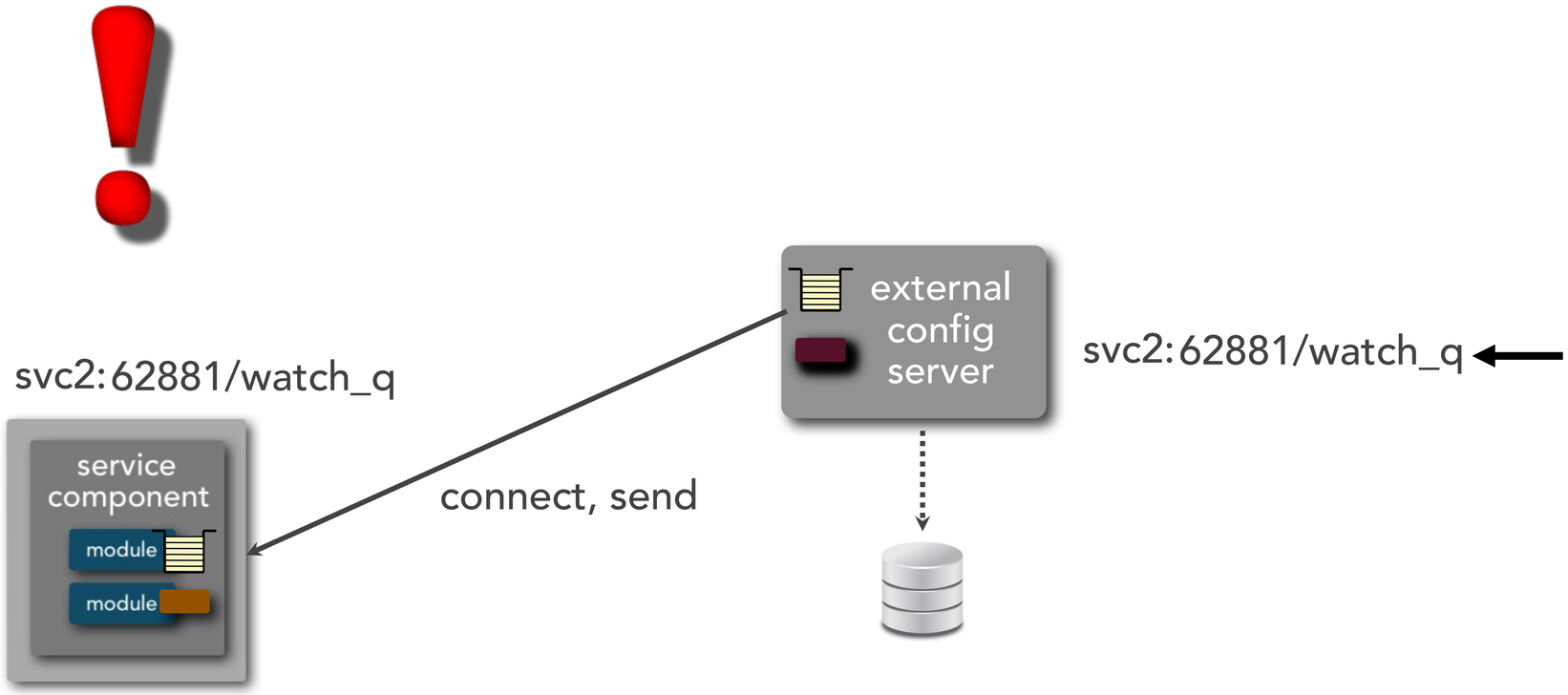
watch notification pattern



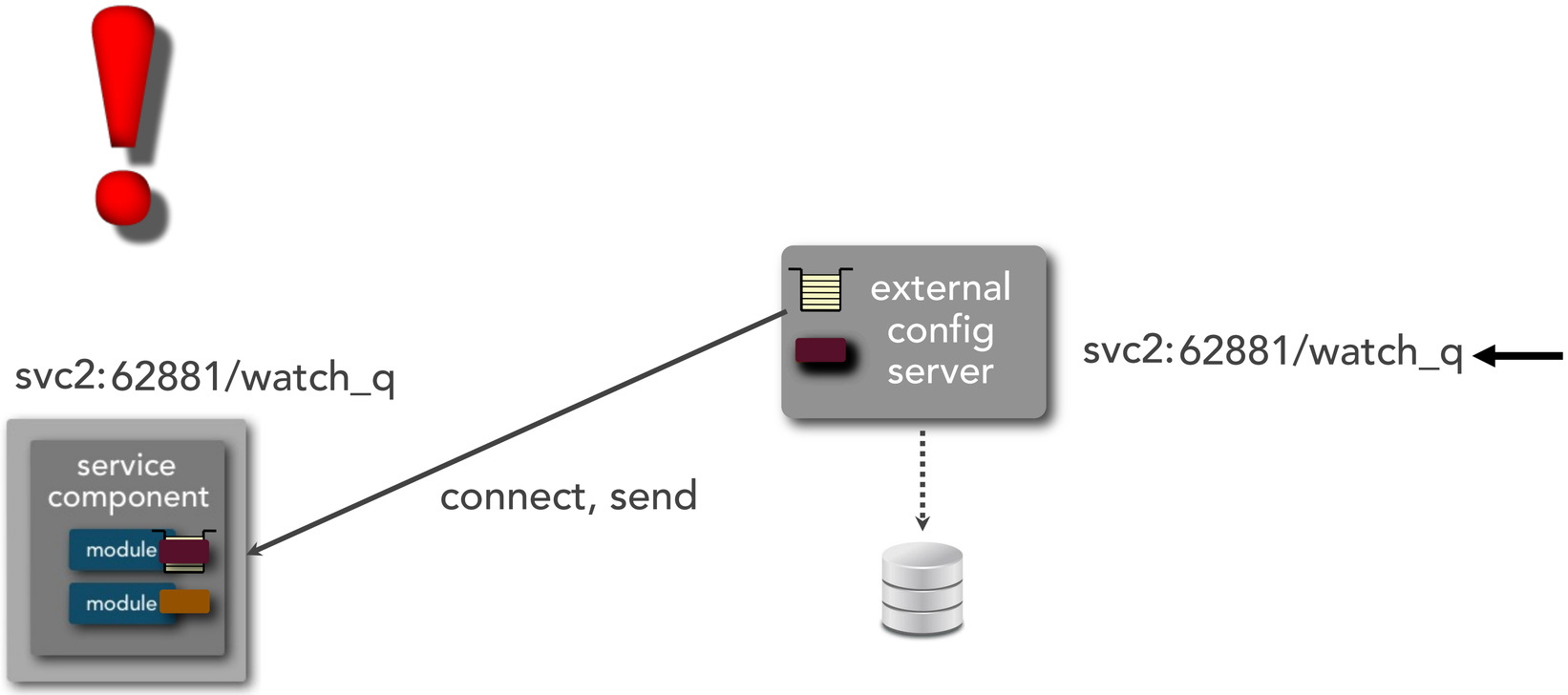
watch notification pattern



watch notification pattern



watch notification pattern



watch notification pattern

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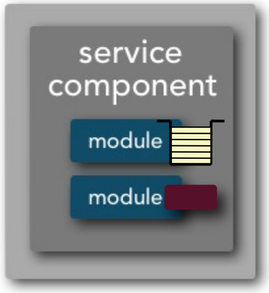

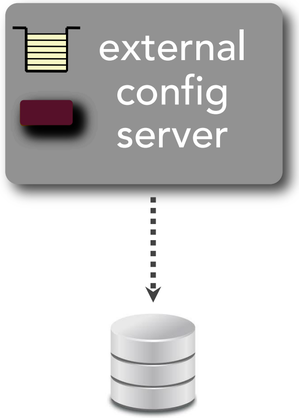

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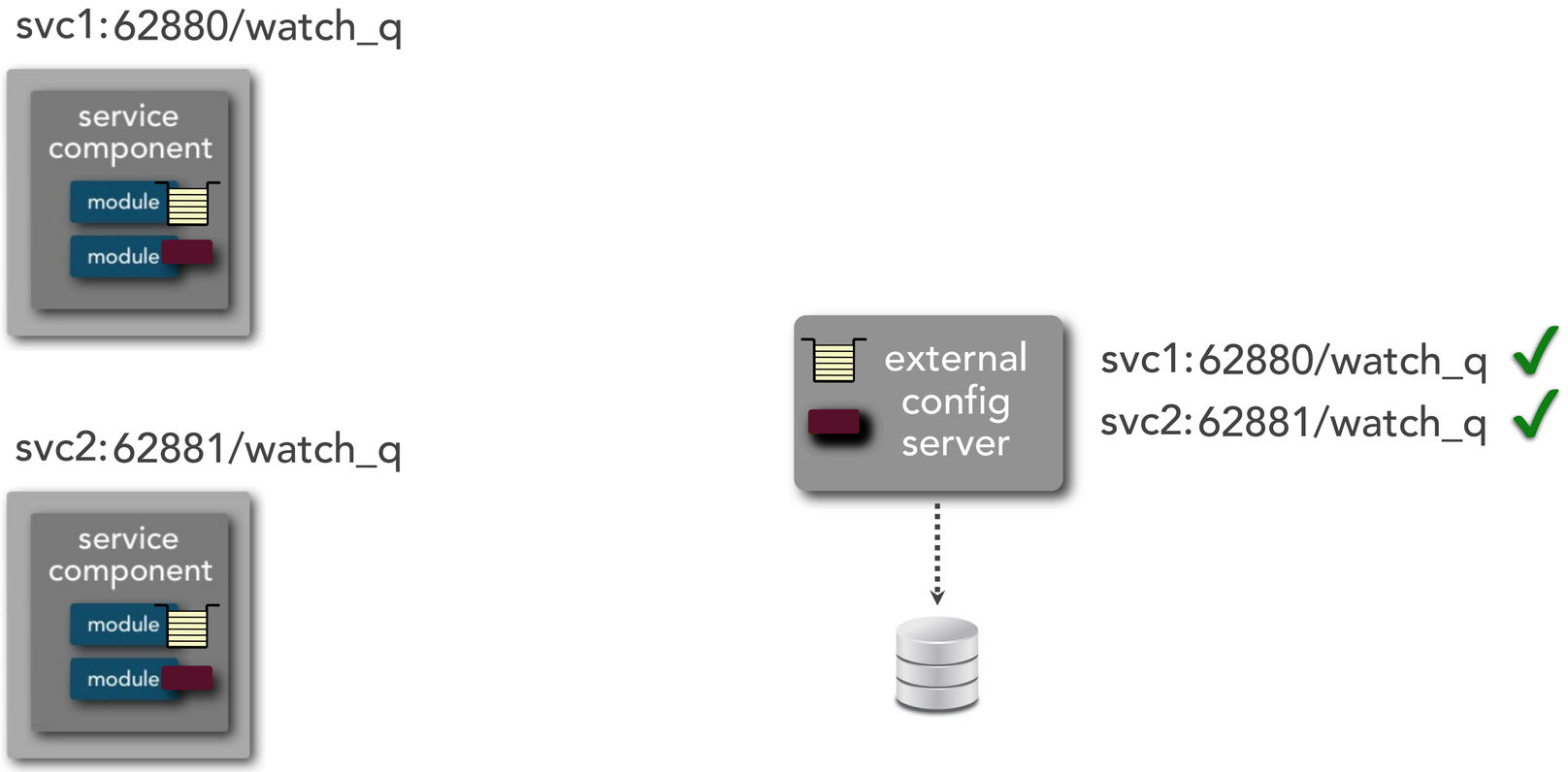
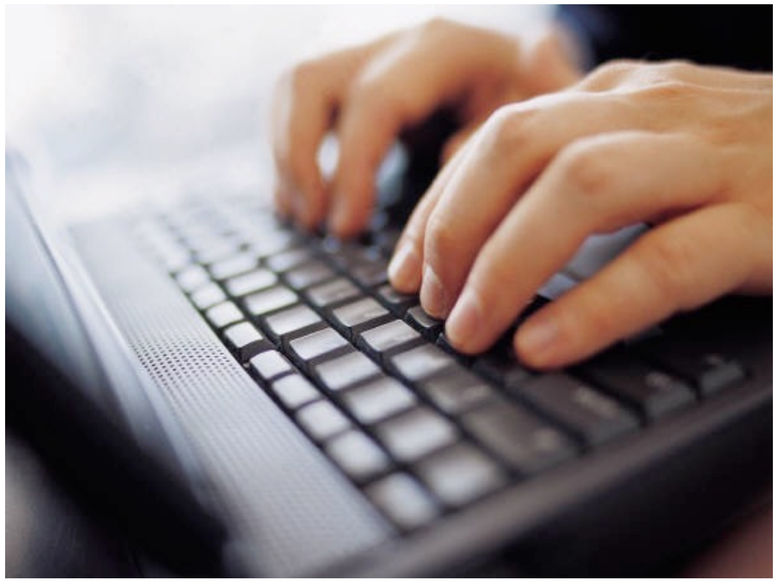
watch notification pattern

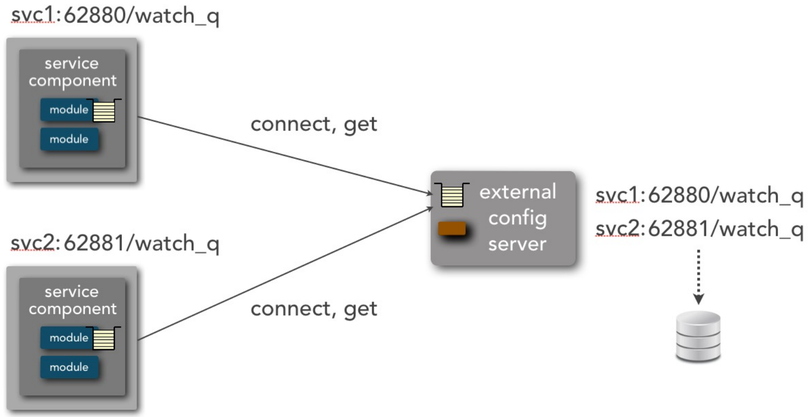


watch notification pattern

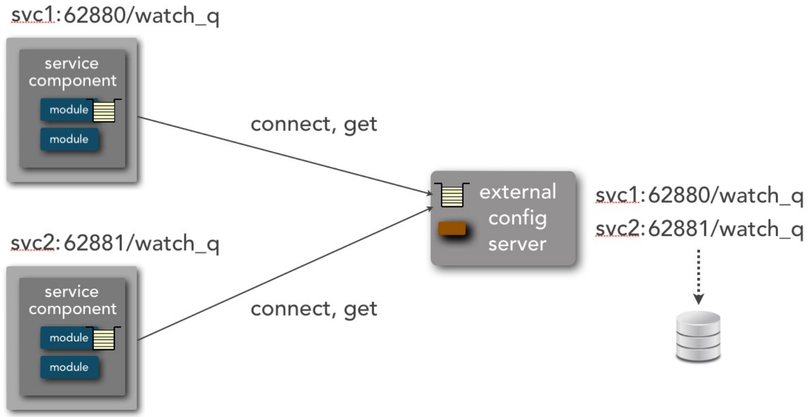


let’s apply the pattern…

watch notification pattern



watch notification pattern

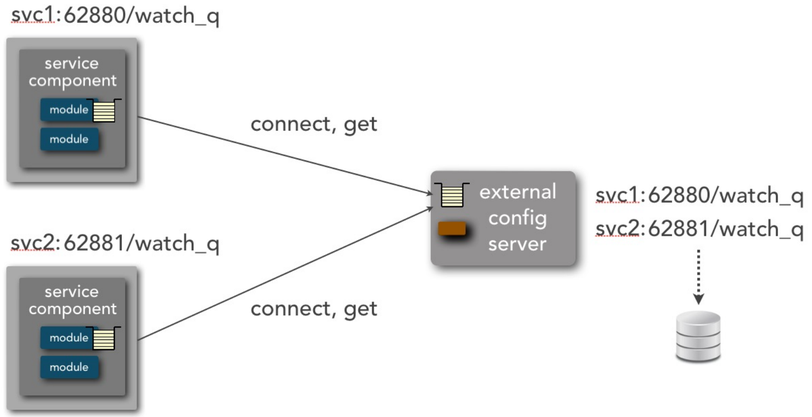


lower bandwidth

fewer connections

fault tolerance

watch notification pattern



lower bandwidth

fewer connections

fault tolerance

performance

complexity

error handing

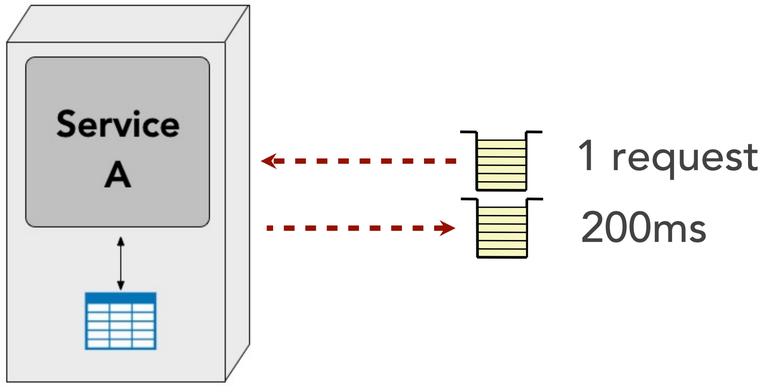
Supervisor Consumer Pattern

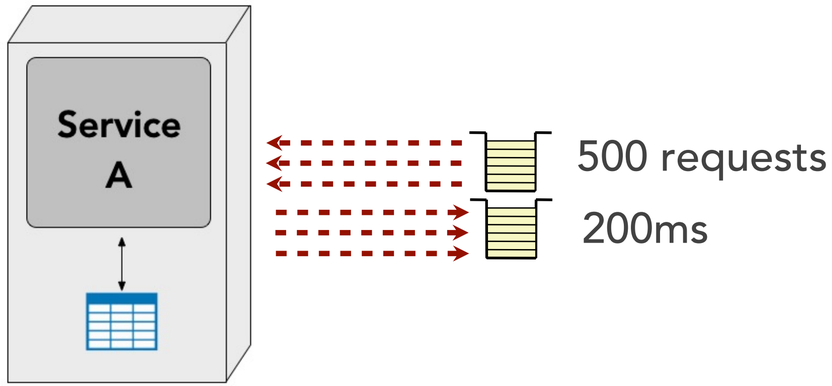
supervisor consumer pattern

https://github.com/wmr513/reactive/tree/master/supervisor

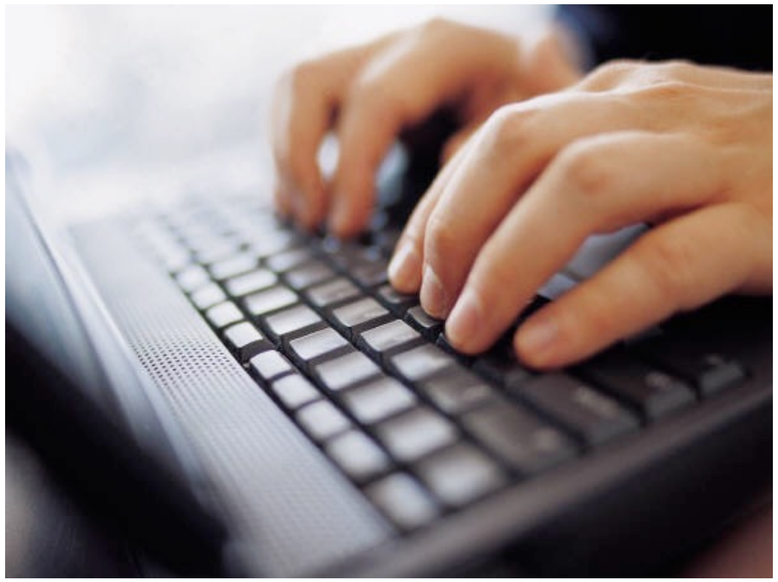
supervisor consumer pattern

"how do I handle varying request load and still maintain a consistent response time?"



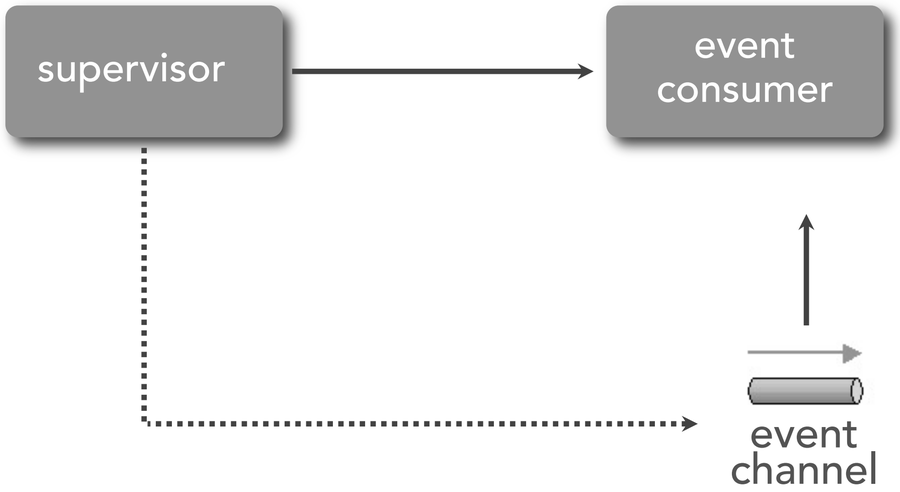


supervisor consumer pattern

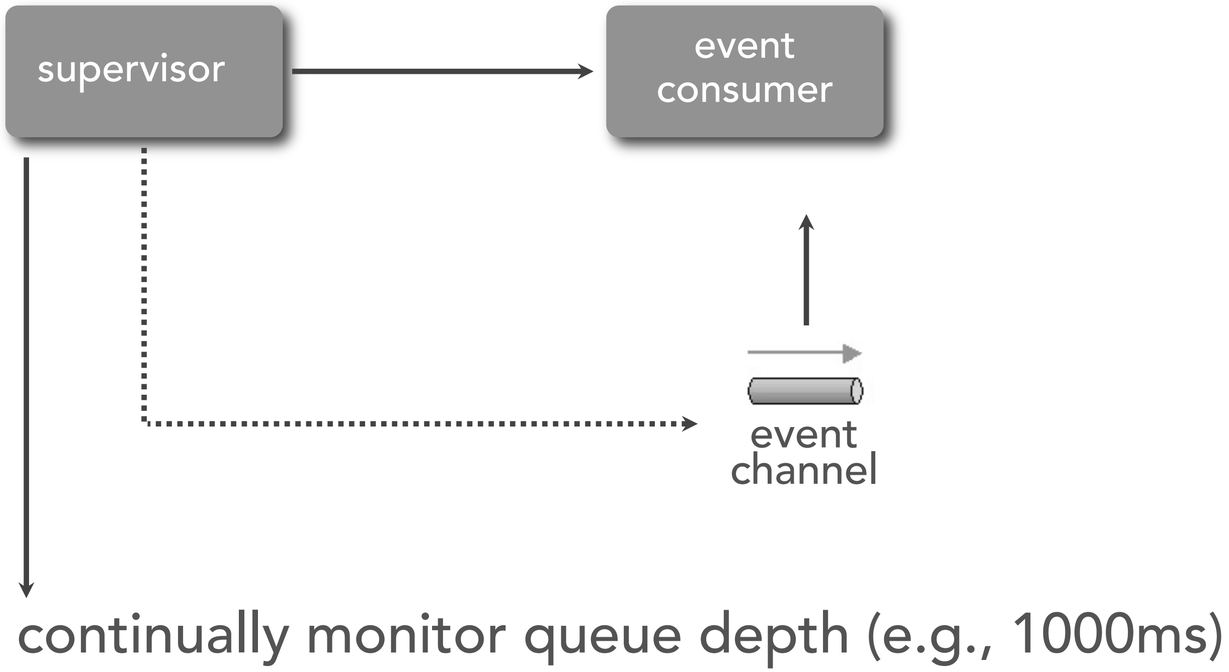


let’s see the issue…

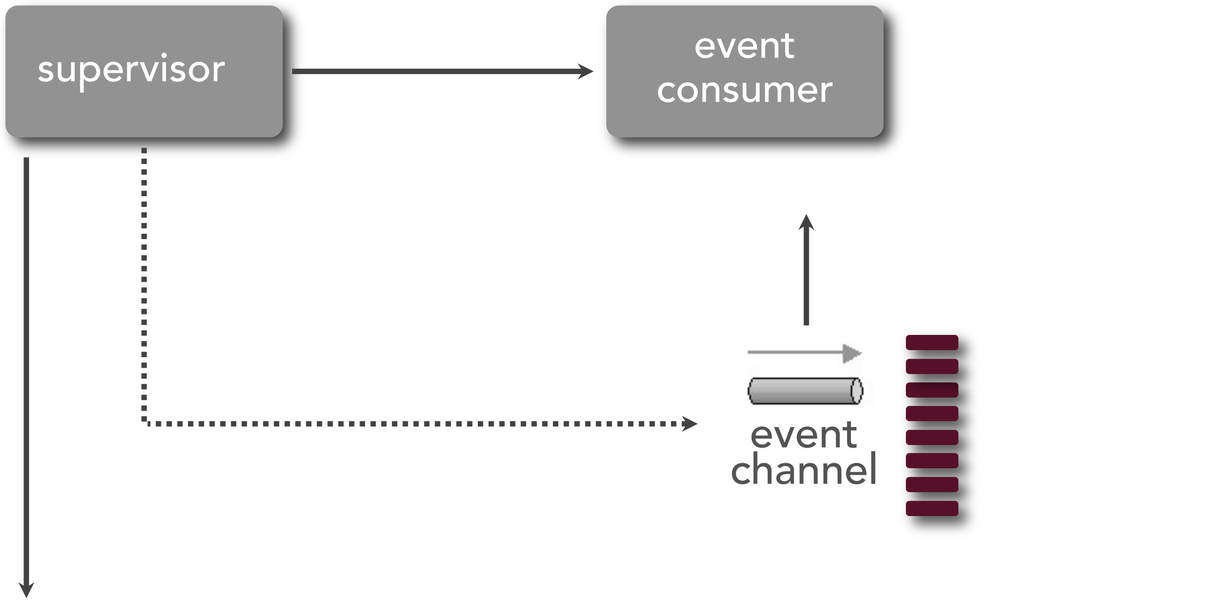
supervisor consumer pattern



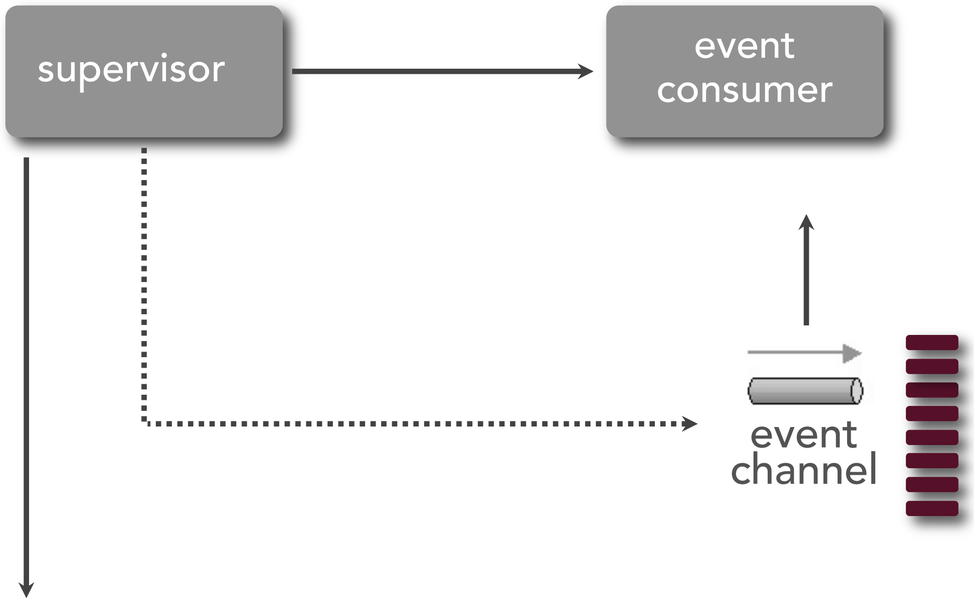
supervisor consumer pattern



supervisor consumer pattern



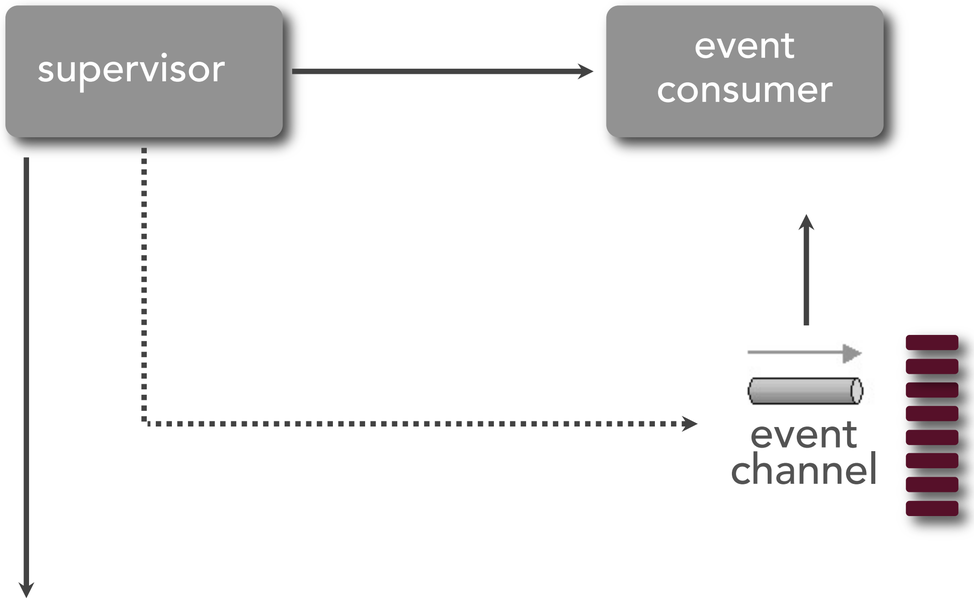
supervisor consumer pattern



continually monitor queue depth (e.g., 1000ms)

determine consumers needed (depth/n)

supervisor consumer pattern

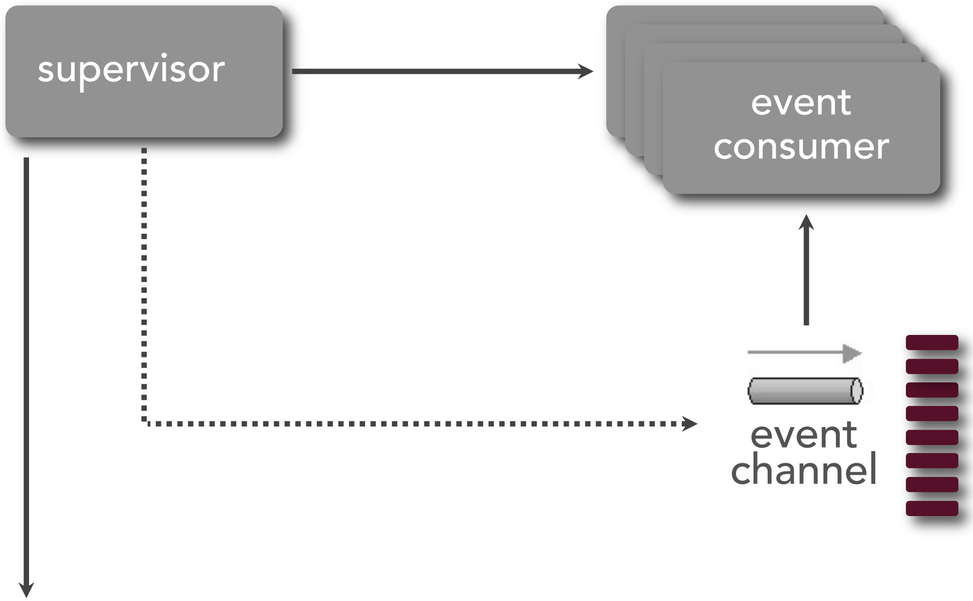


continually monitor queue depth (e.g., 1000ms)

determine consumers needed (depth/n)

apply max threshold (e.g., 500 consumers)

supervisor consumer pattern



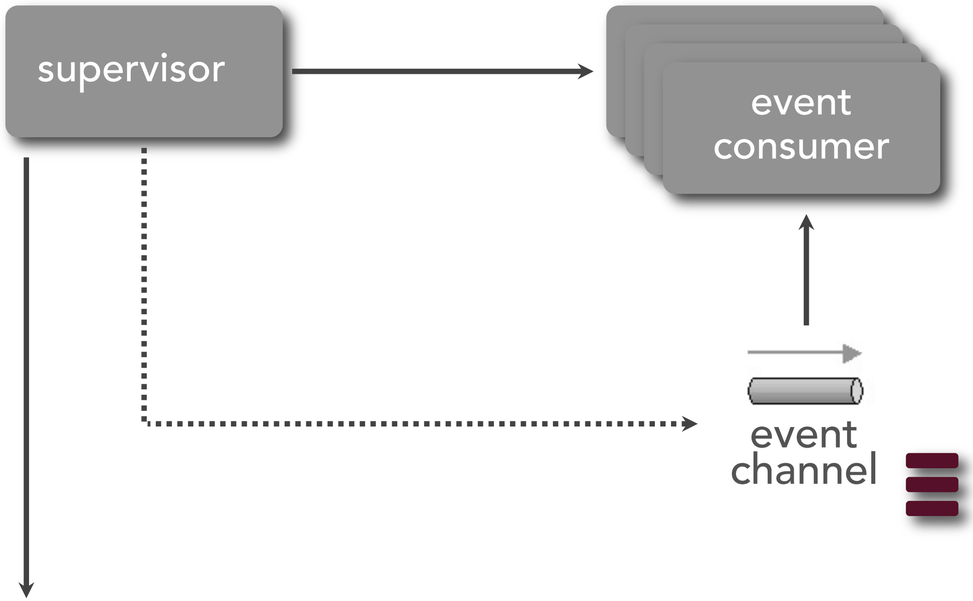
continually monitor queue depth (e.g., 1000ms)

determine consumers needed (depth/n)

apply max threshold (e.g., 500 consumers)

add or remove consumers as needed

supervisor consumer pattern



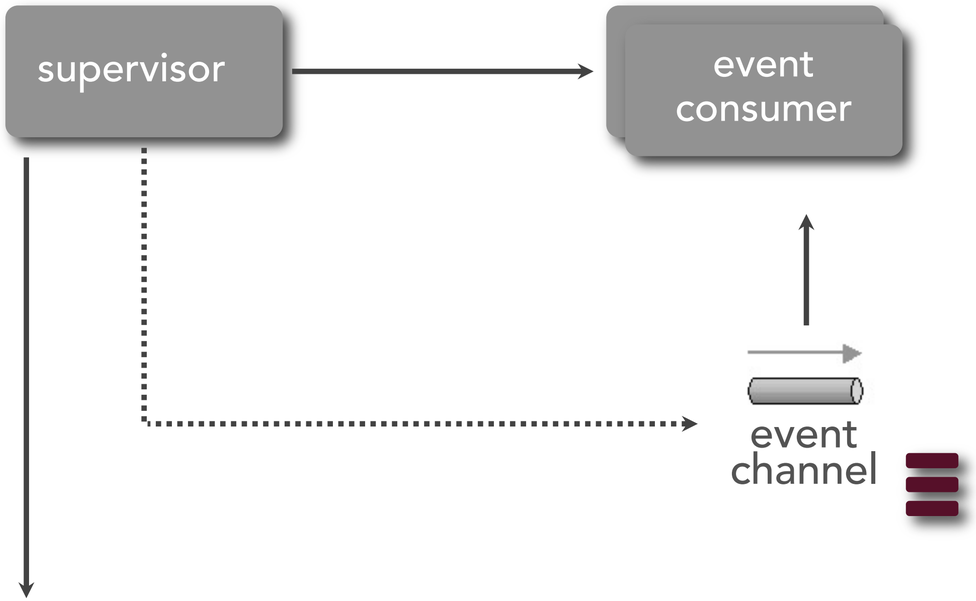
continually monitor queue depth (e.g., 1000ms)

determine consumers needed (depth/n)

apply max threshold (e.g., 500 consumers)

add or remove consumers as needed

supervisor consumer pattern



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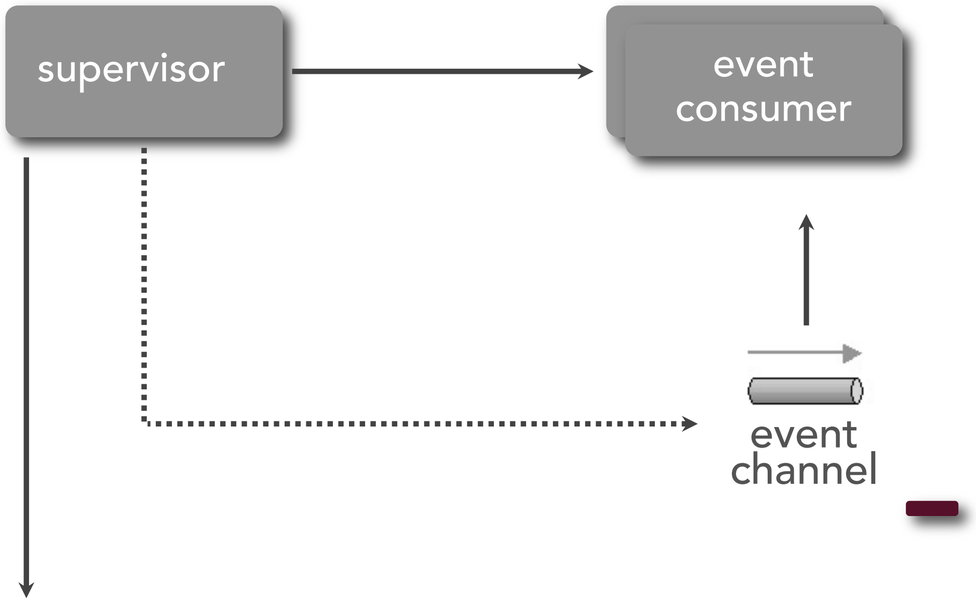
supervisor consumer pattern



continually monitor queue depth (e.g., 1000ms)

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apply max threshold (e.g., 500 consumers)

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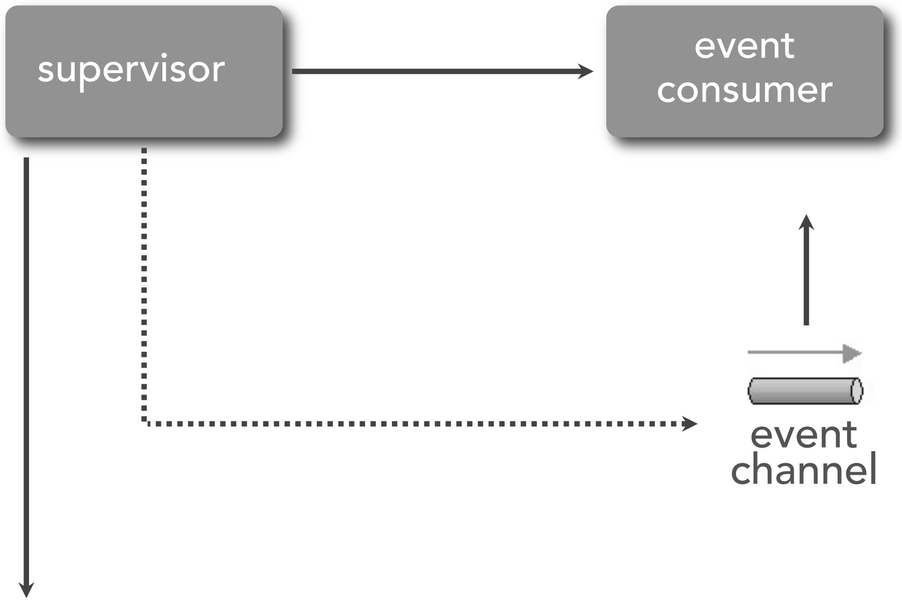
supervisor consumer pattern



continually monitor queue depth (e.g., 1000ms)

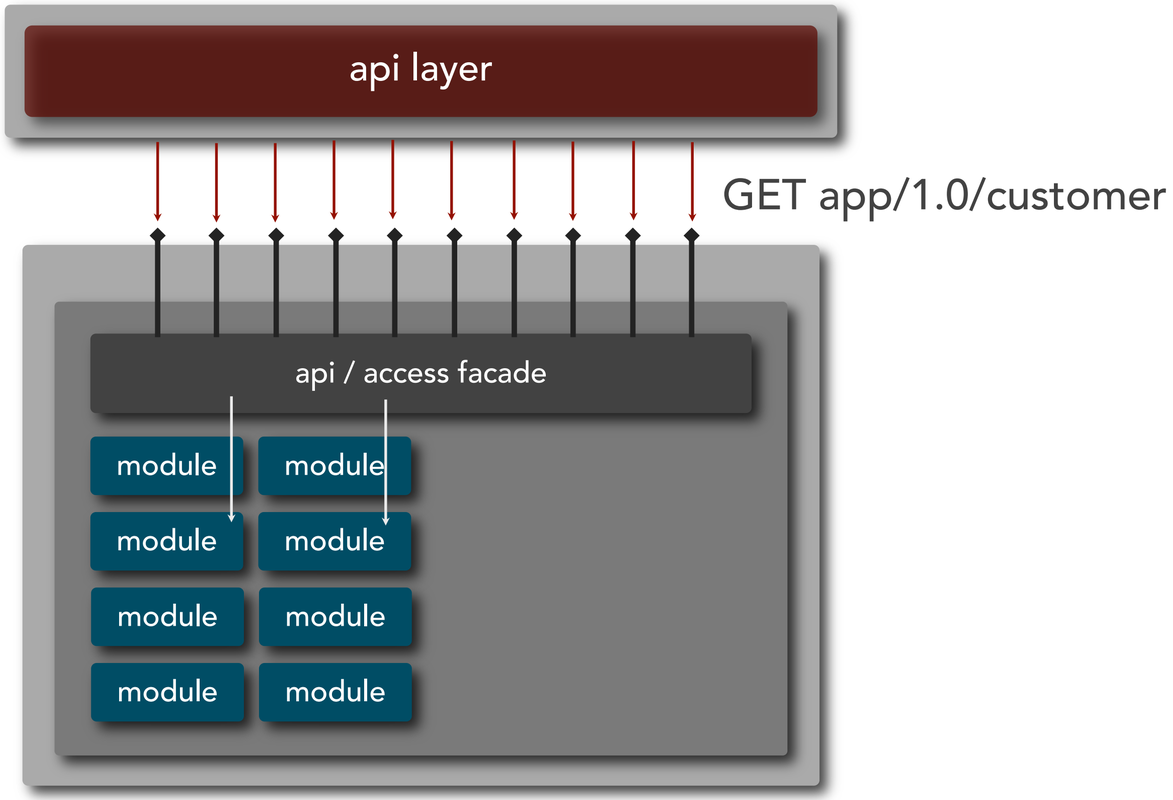
determine consumers needed (depth/n)

apply max threshold (e.g., 500 consumers)

add or remove consumers as needed

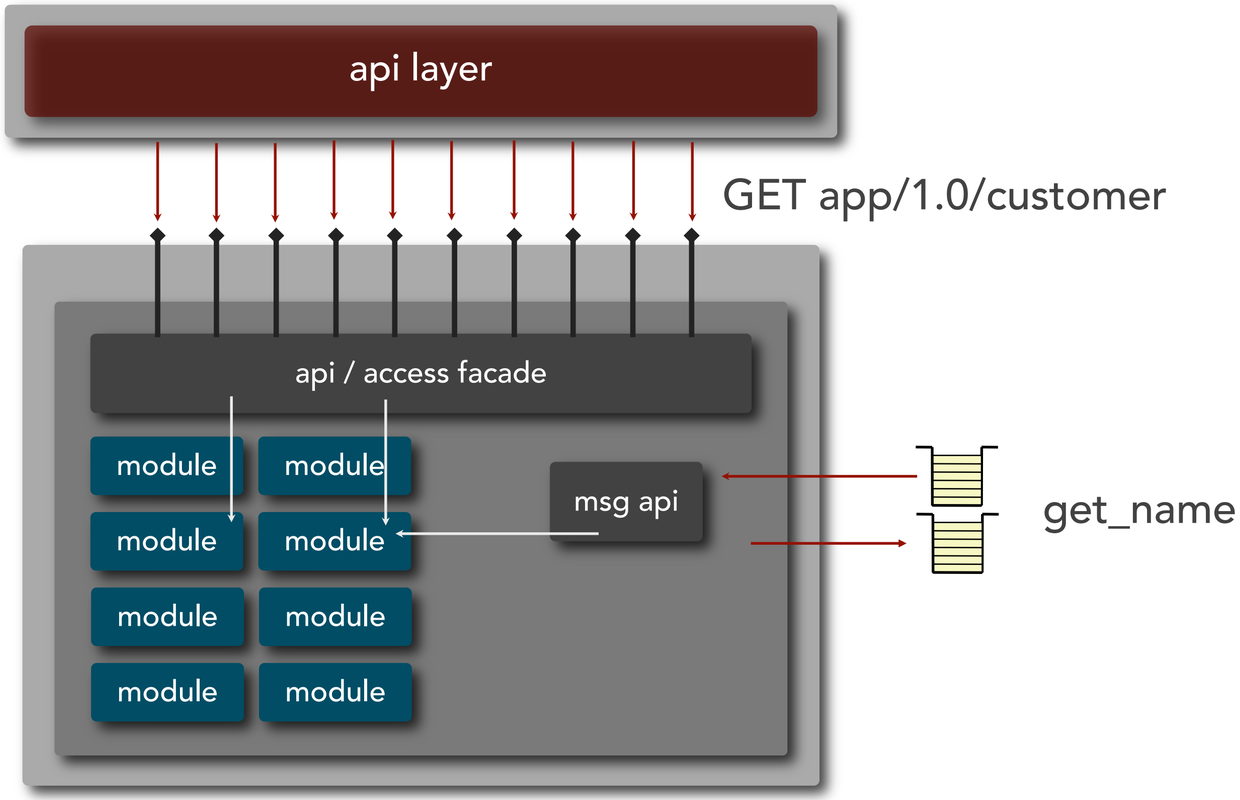
supervisor consumer pattern

inter-service communication



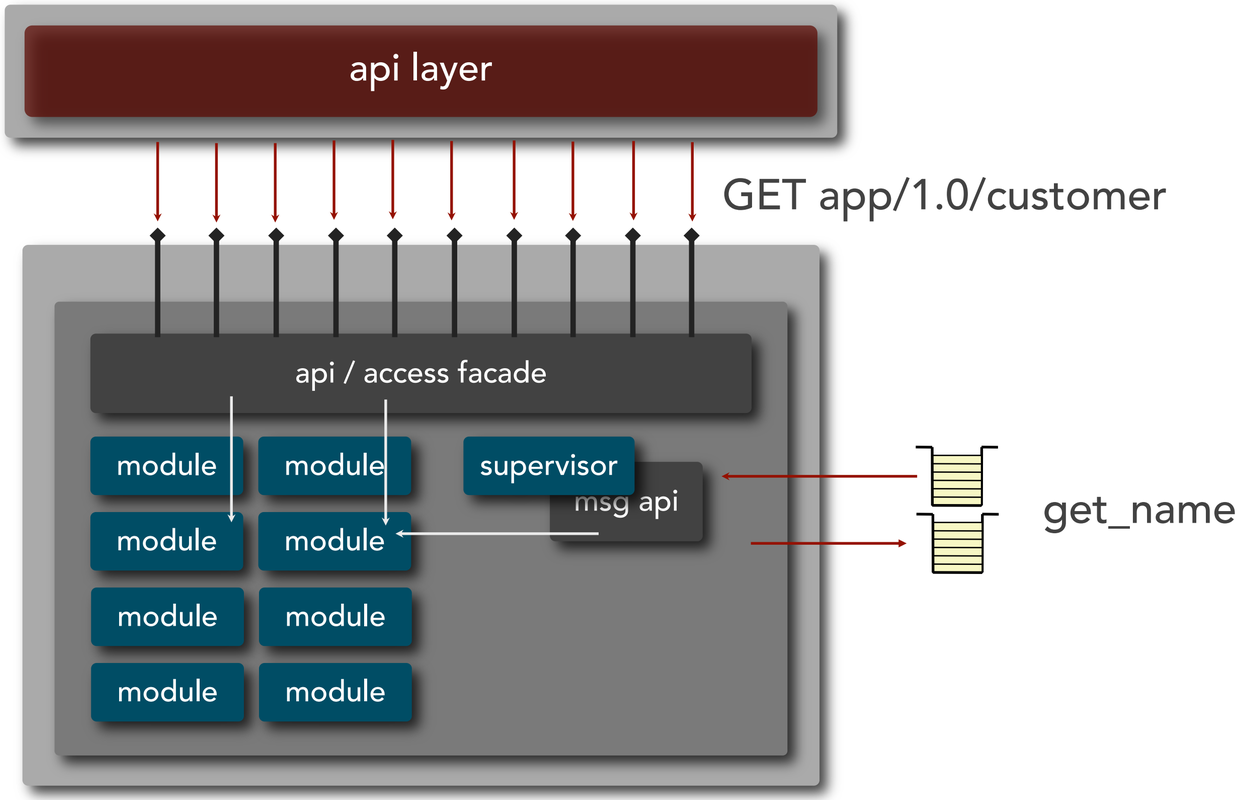
supervisor consumer pattern

inter-service communication



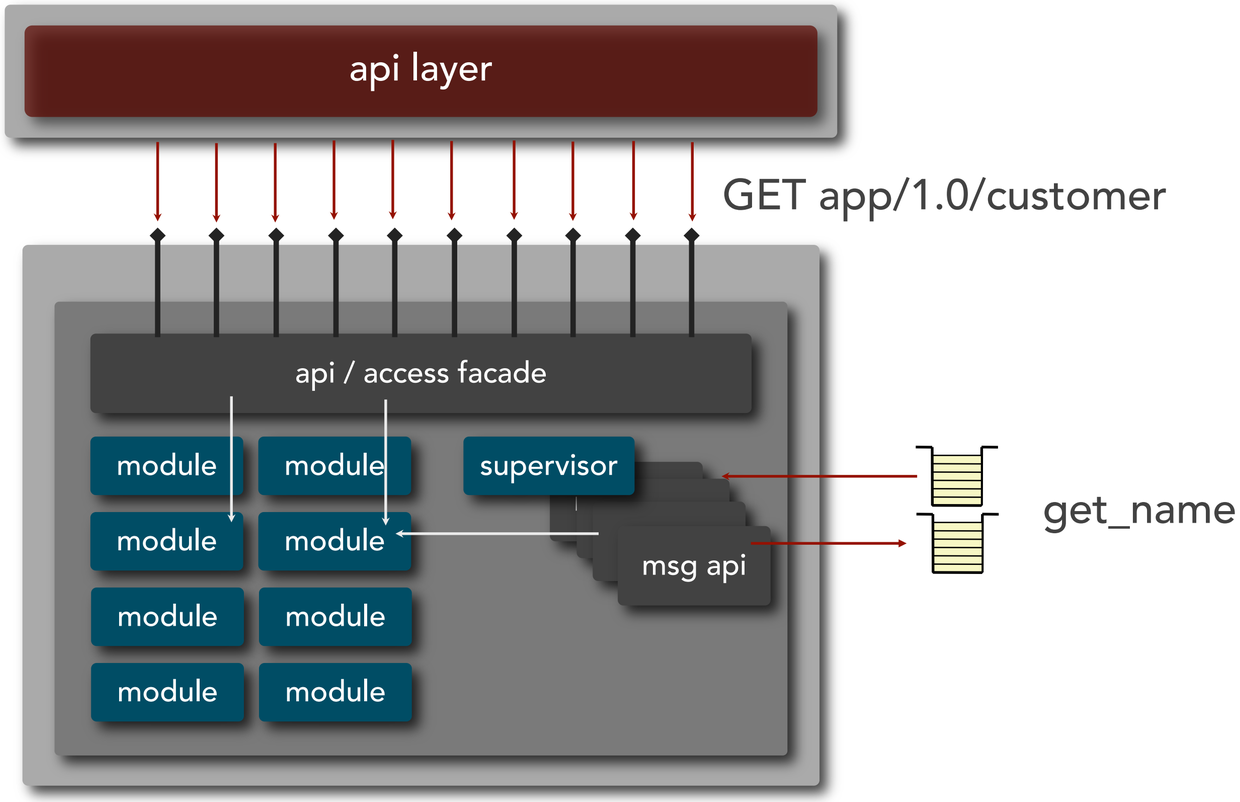
supervisor consumer pattern

inter-service communication



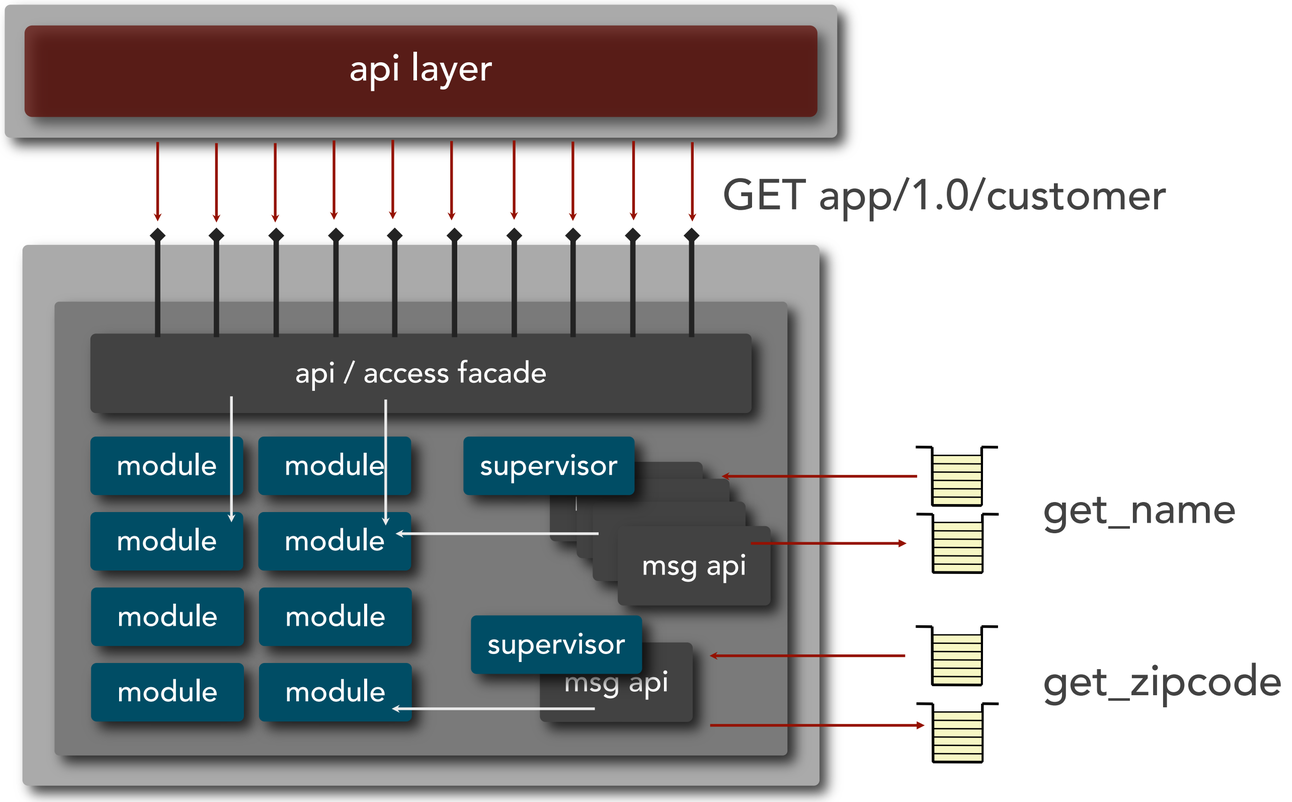
supervisor consumer pattern

inter-service communication

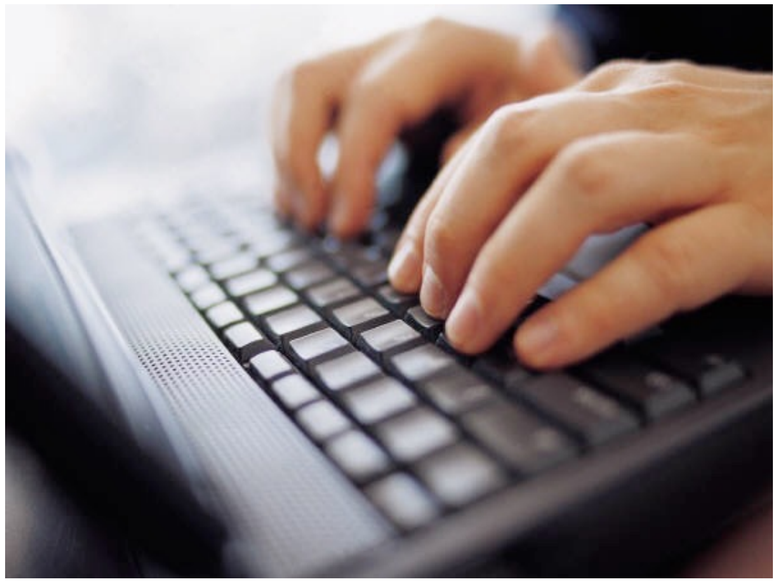


supervisor consumer pattern

inter-service communication

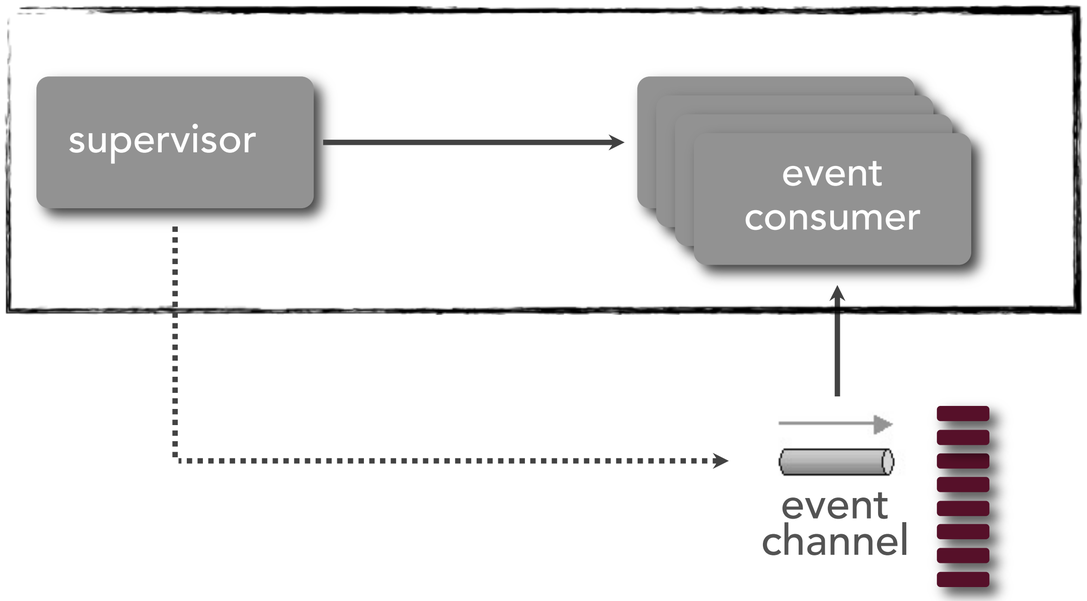


supervisor consumer pattern

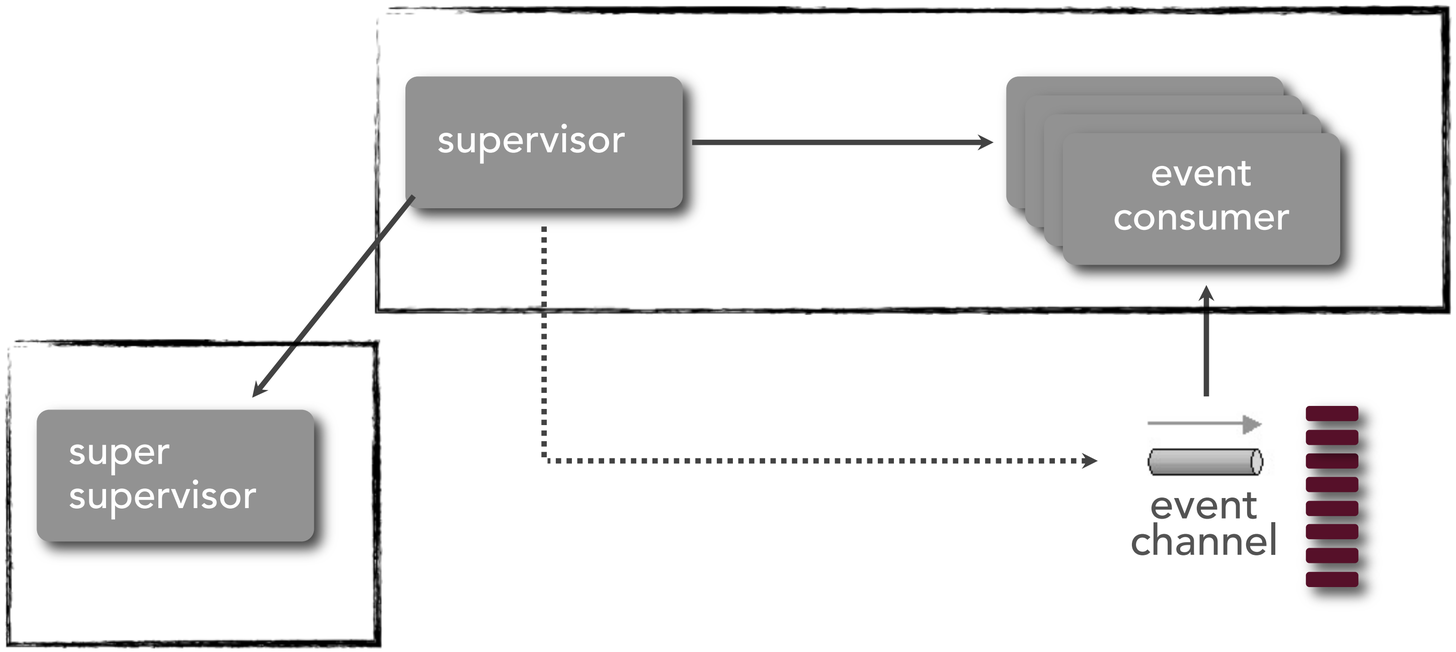


let’s see this in action…

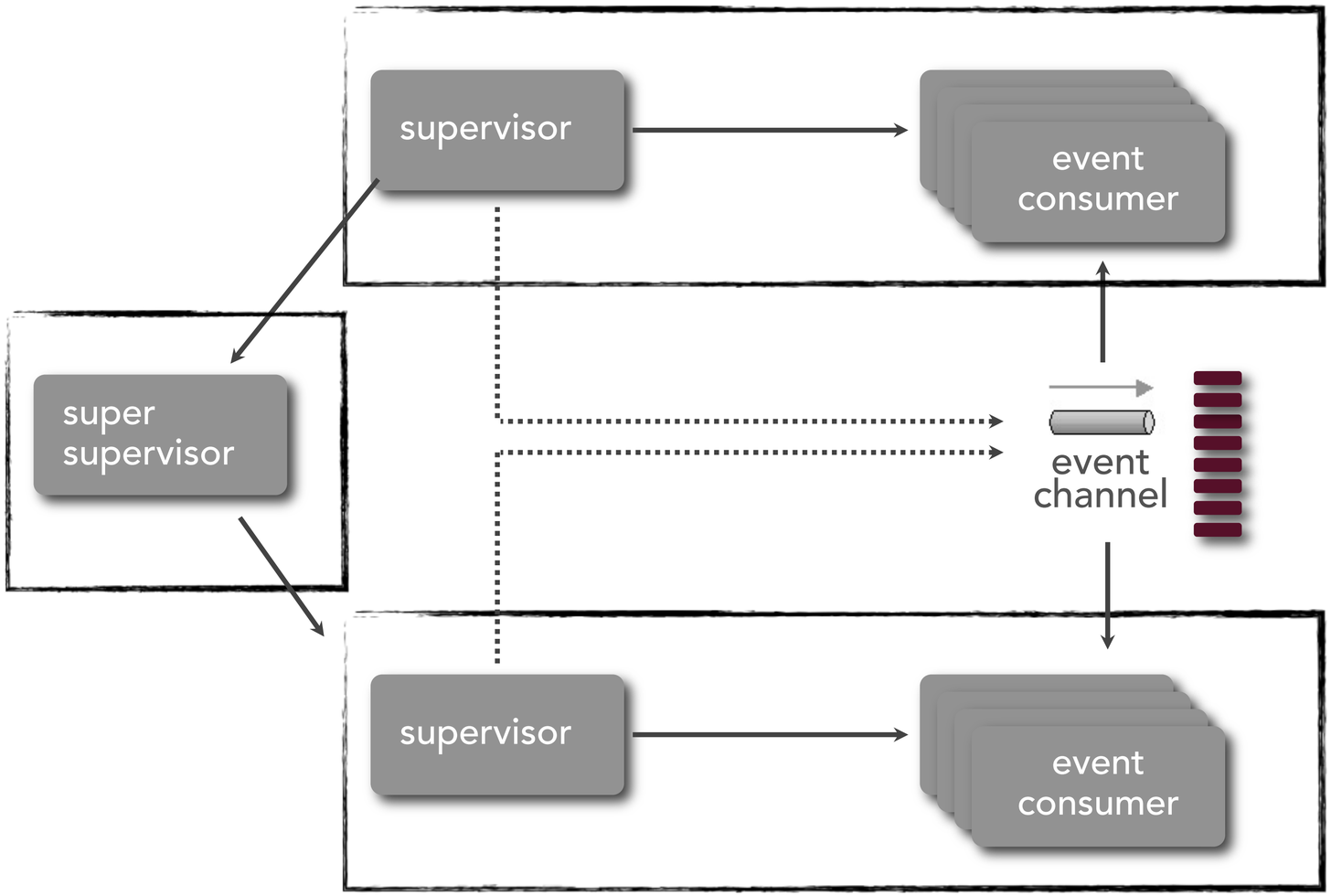
supervisor consumer pattern



supervisor consumer pattern



supervisor consumer pattern



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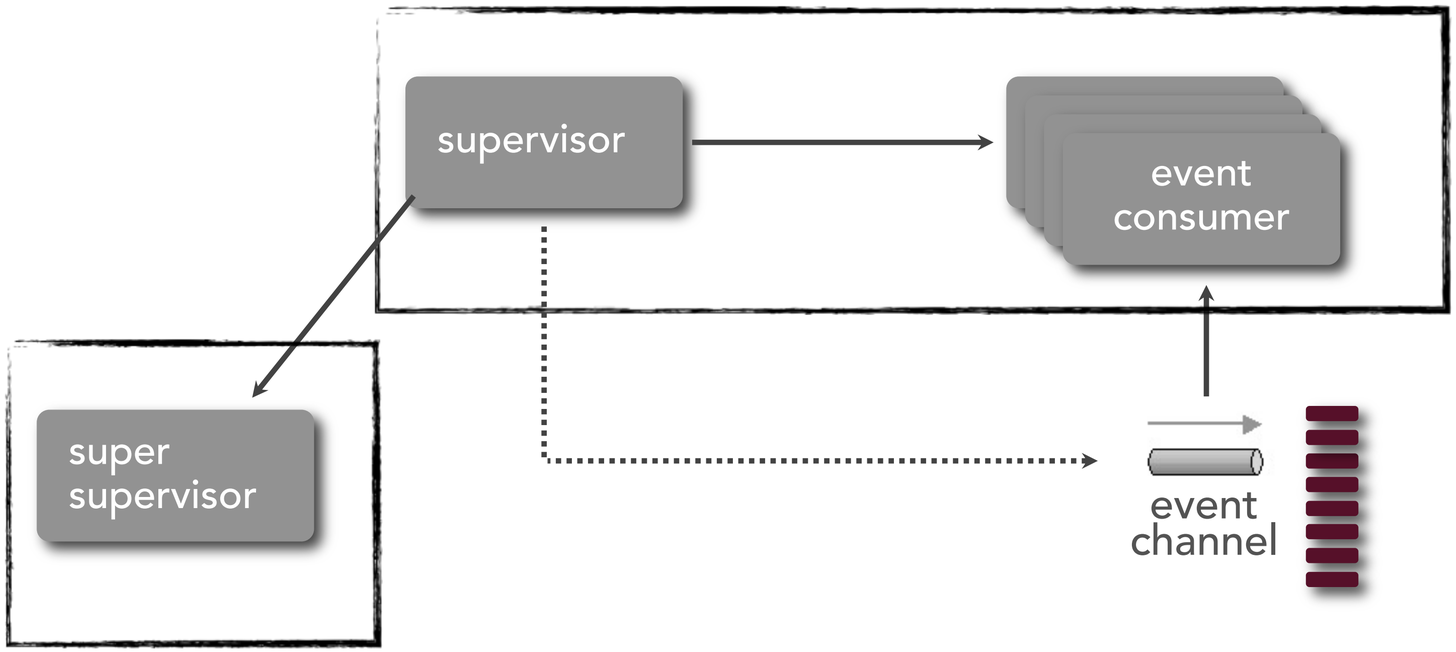

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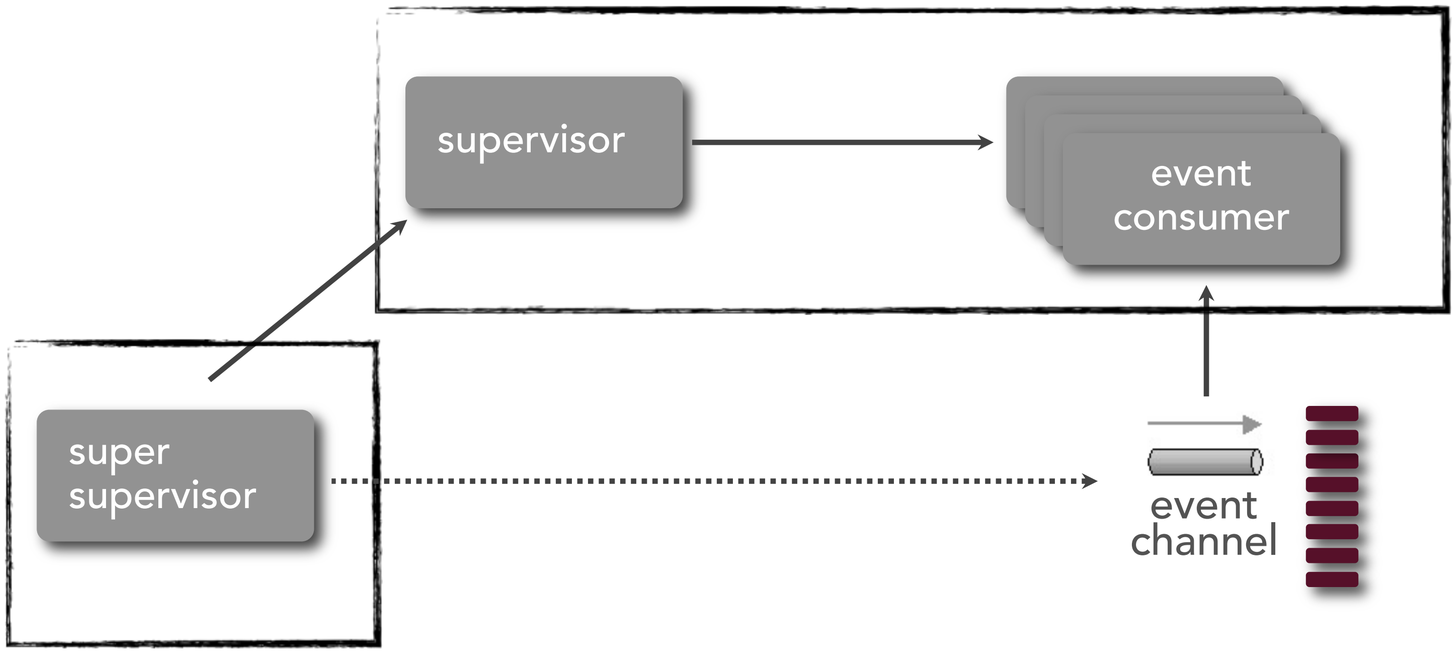

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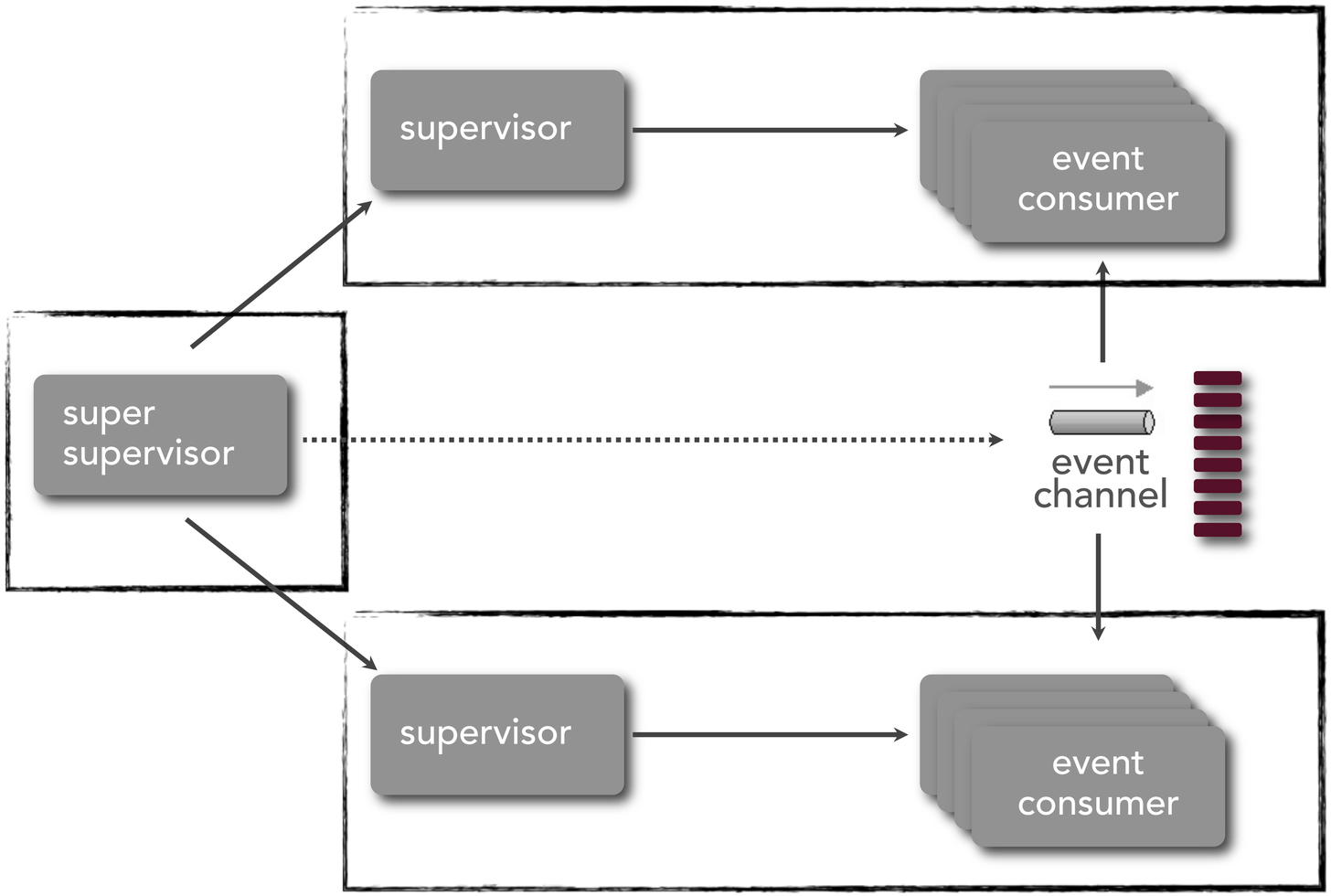

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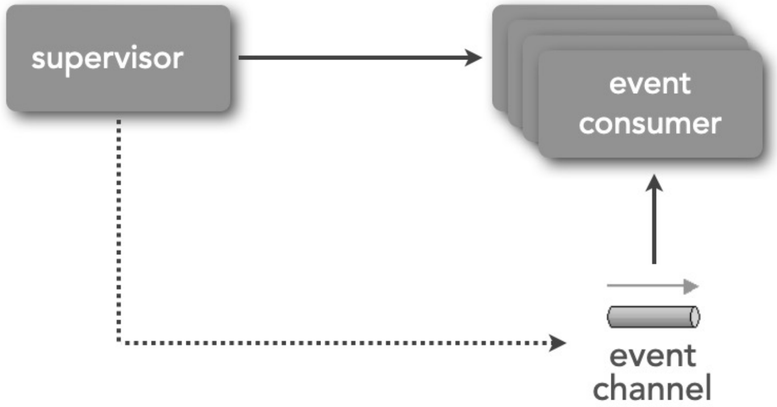
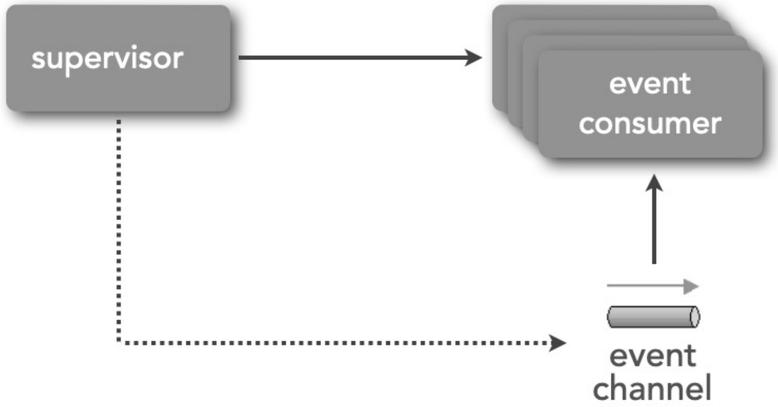


supervisor consumer pattern



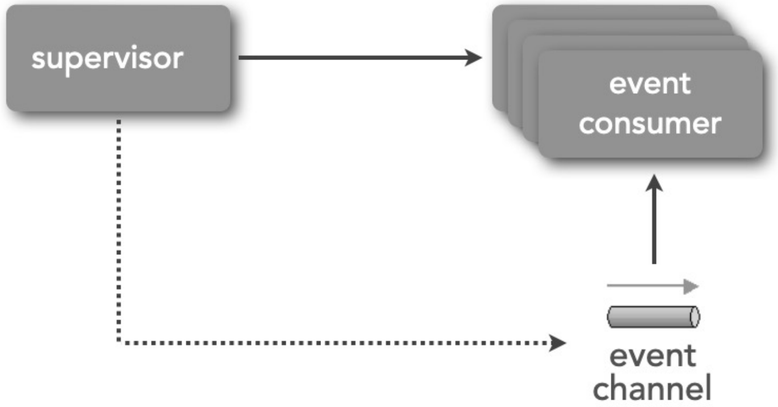
programmatic elasticity

consistent responsiveness

optimized thread allocation

optimized memory usage

supervisor consumer pattern



programmatic elasticity

consistent responsiveness

optimized thread allocation

optimized memory usage

increased complexity

possible thread saturation

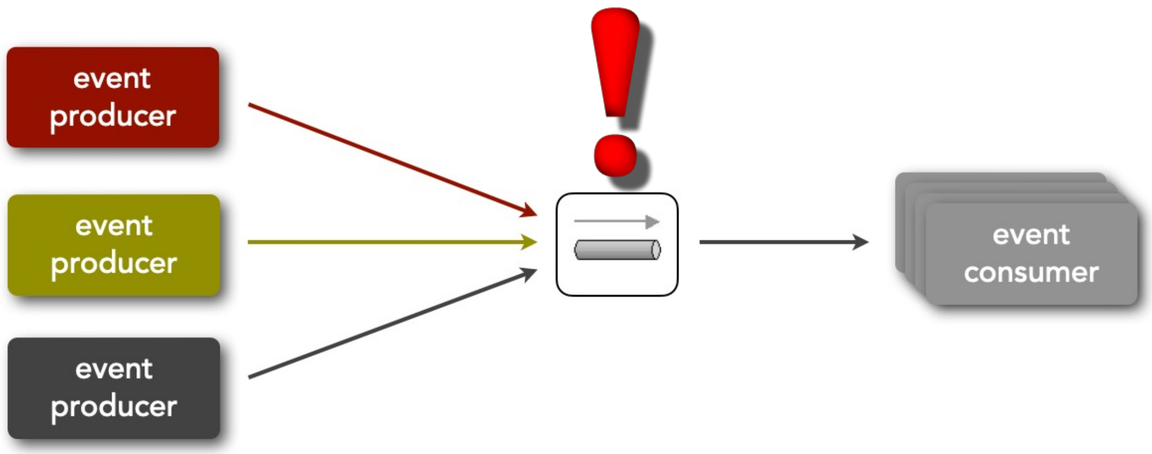
possible memory errors

impact on other requests

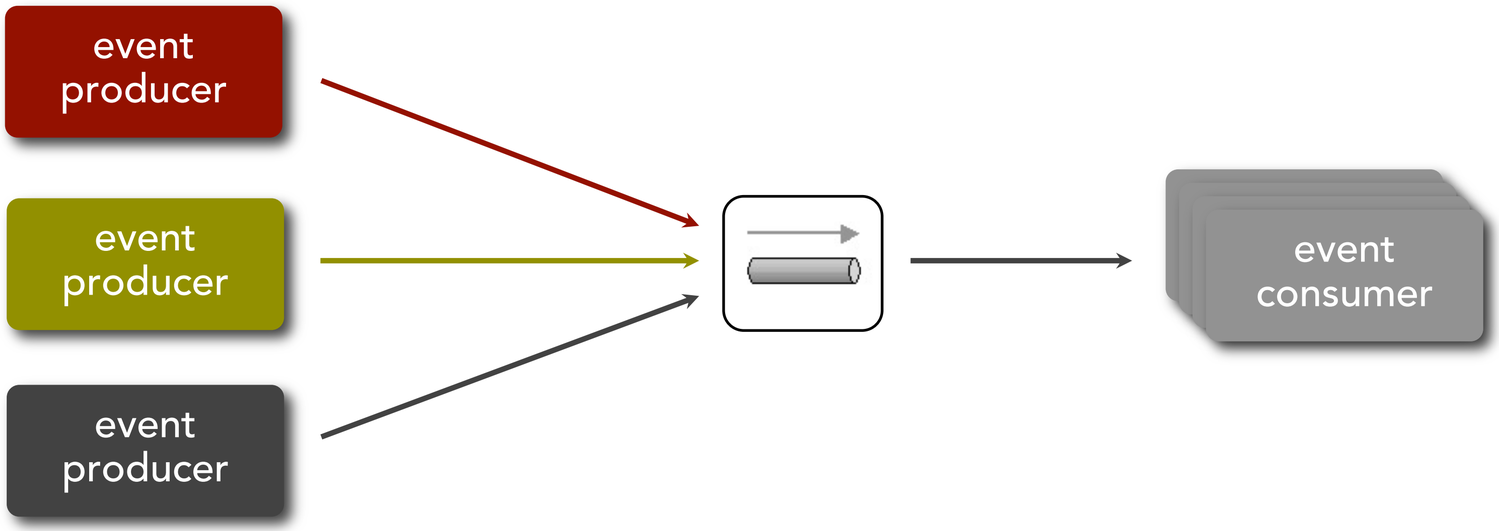
Multi-Broker Pattern

multi-broker pattern

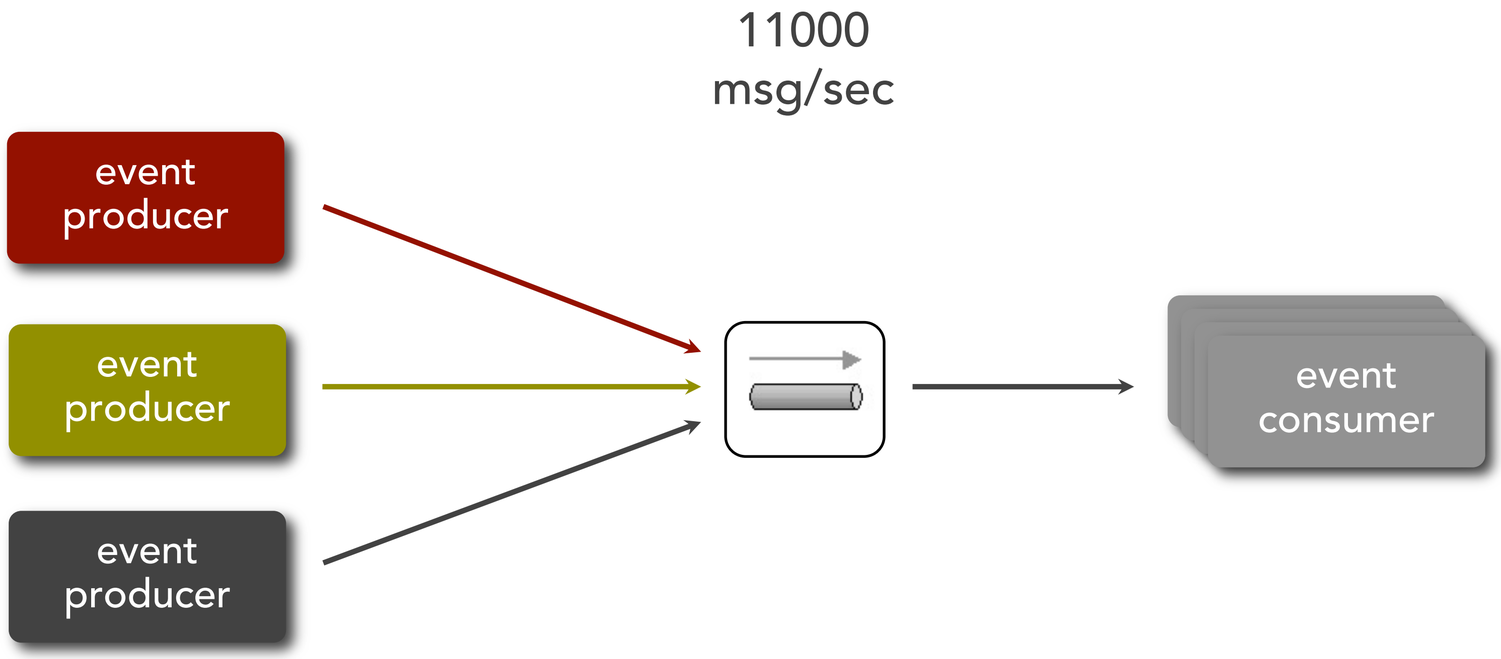
"how can I increase the throughput and capacity of events through the system?"



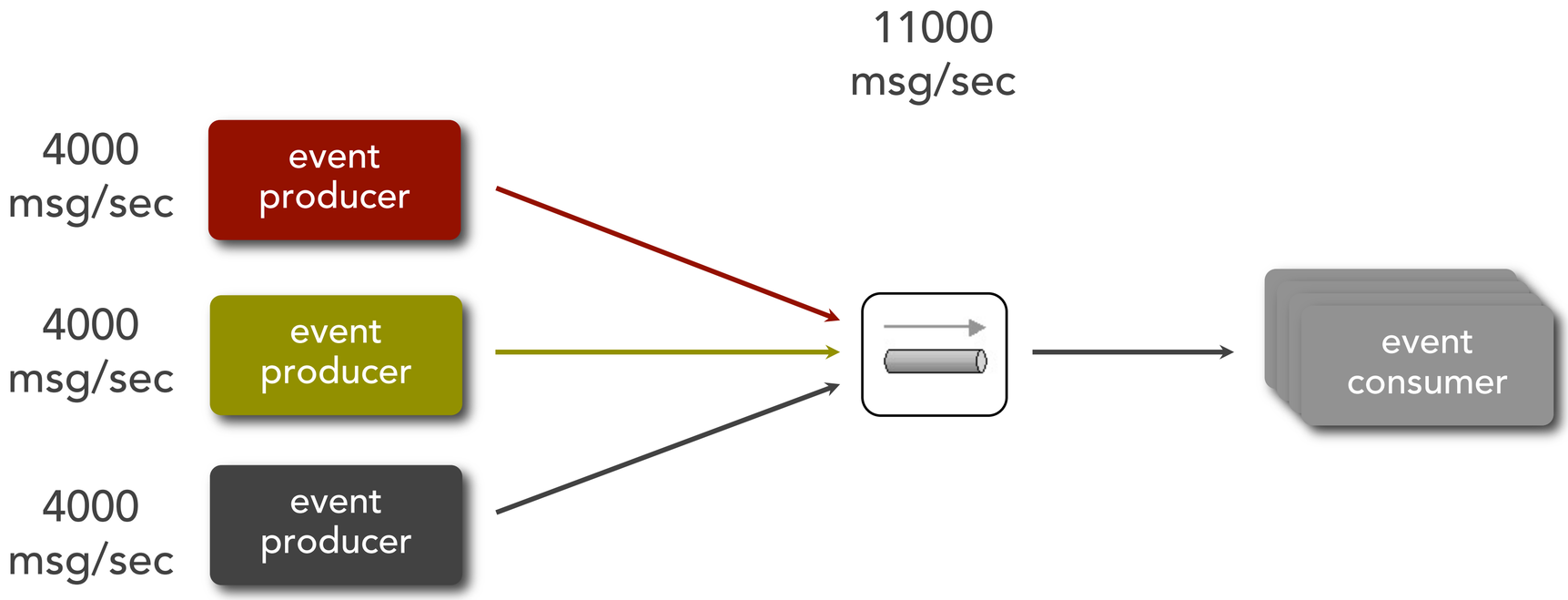
multi-broker pattern



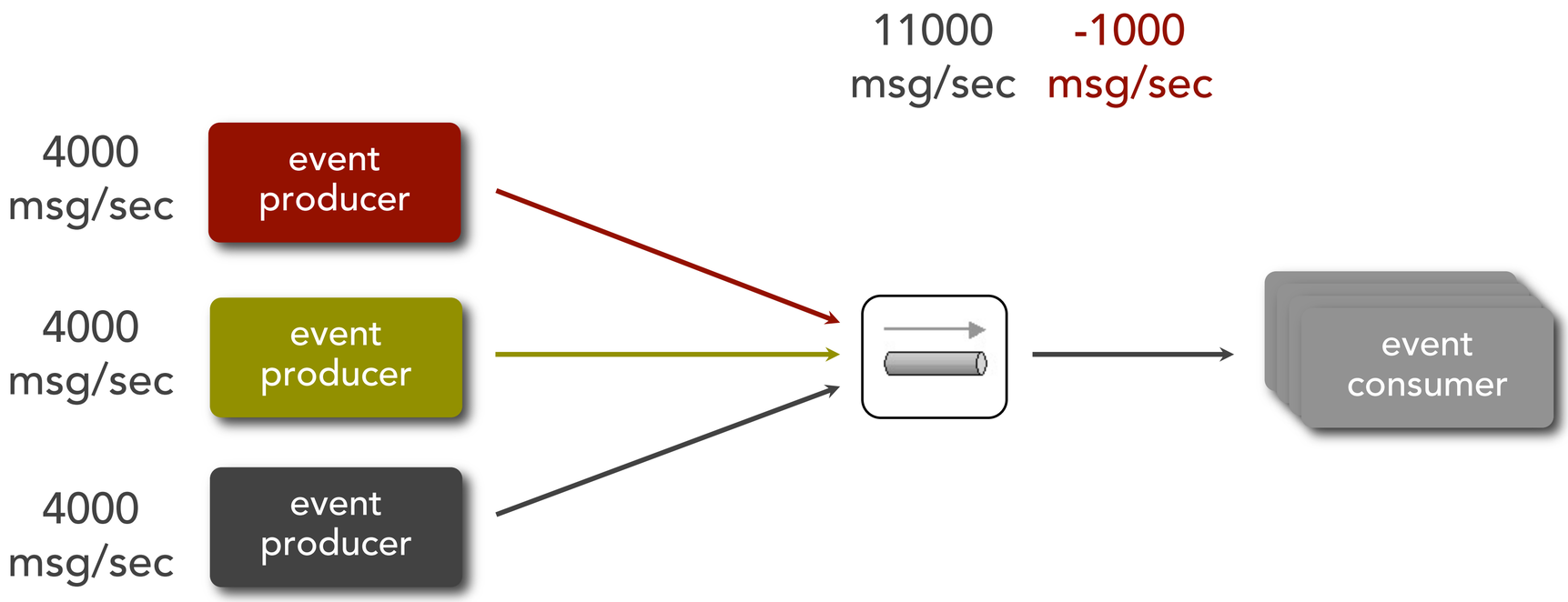
multi-broker pattern



multi-broker pattern



multi-broker pattern



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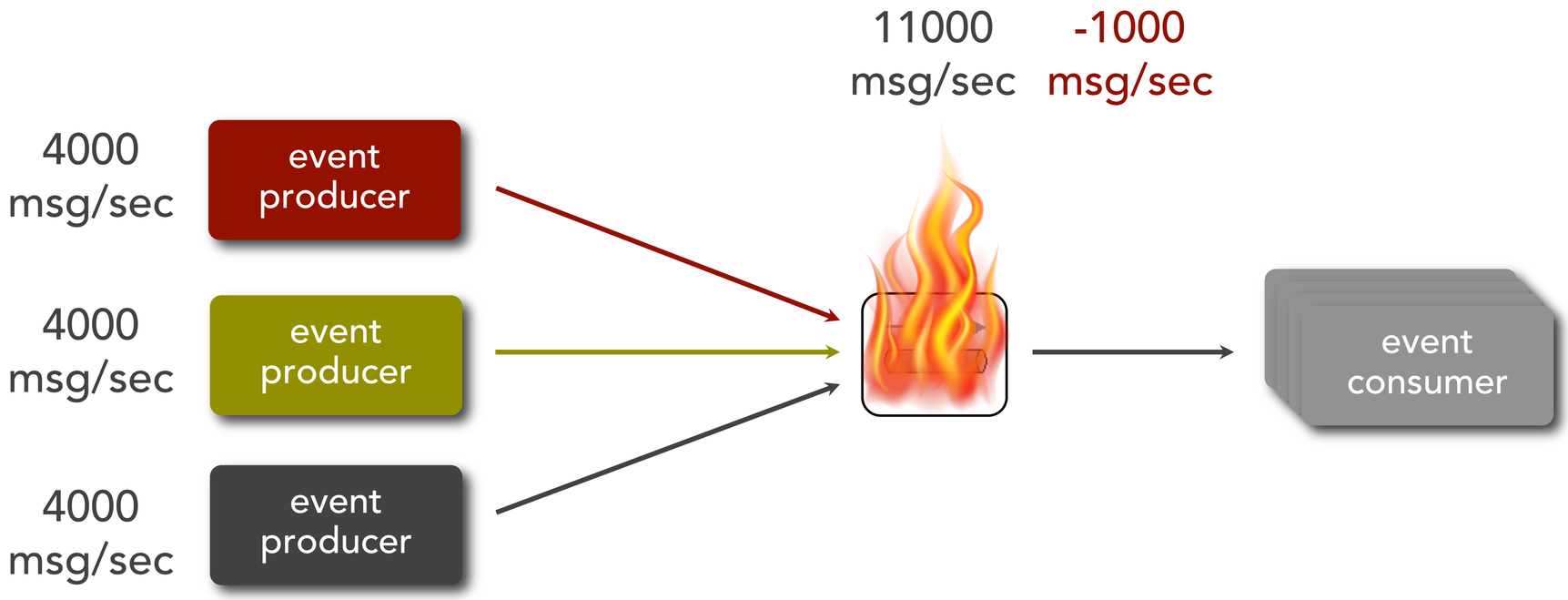

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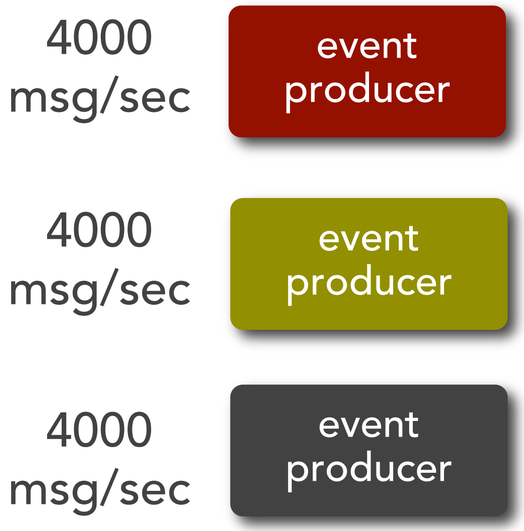
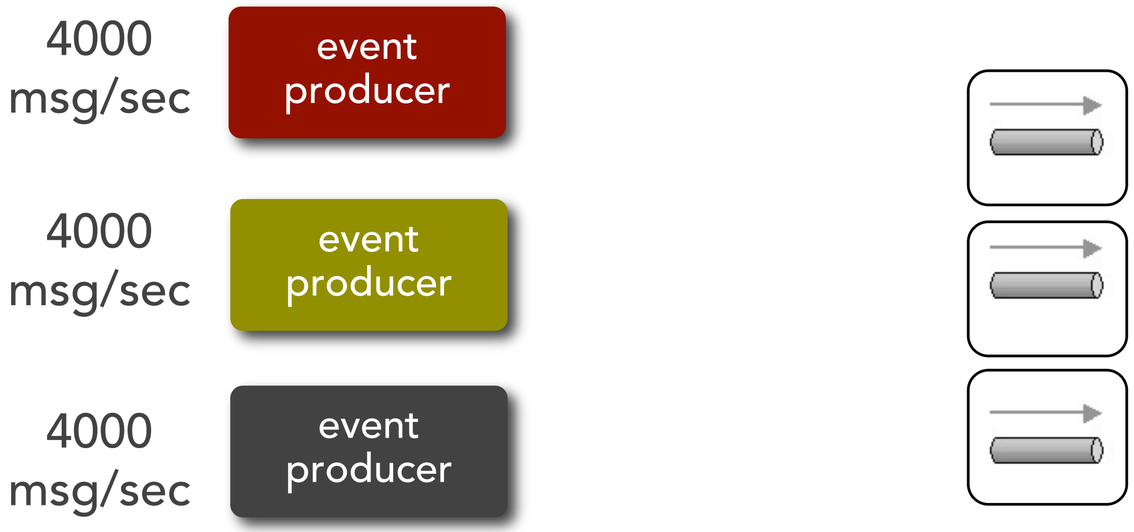


multi-broker pattern



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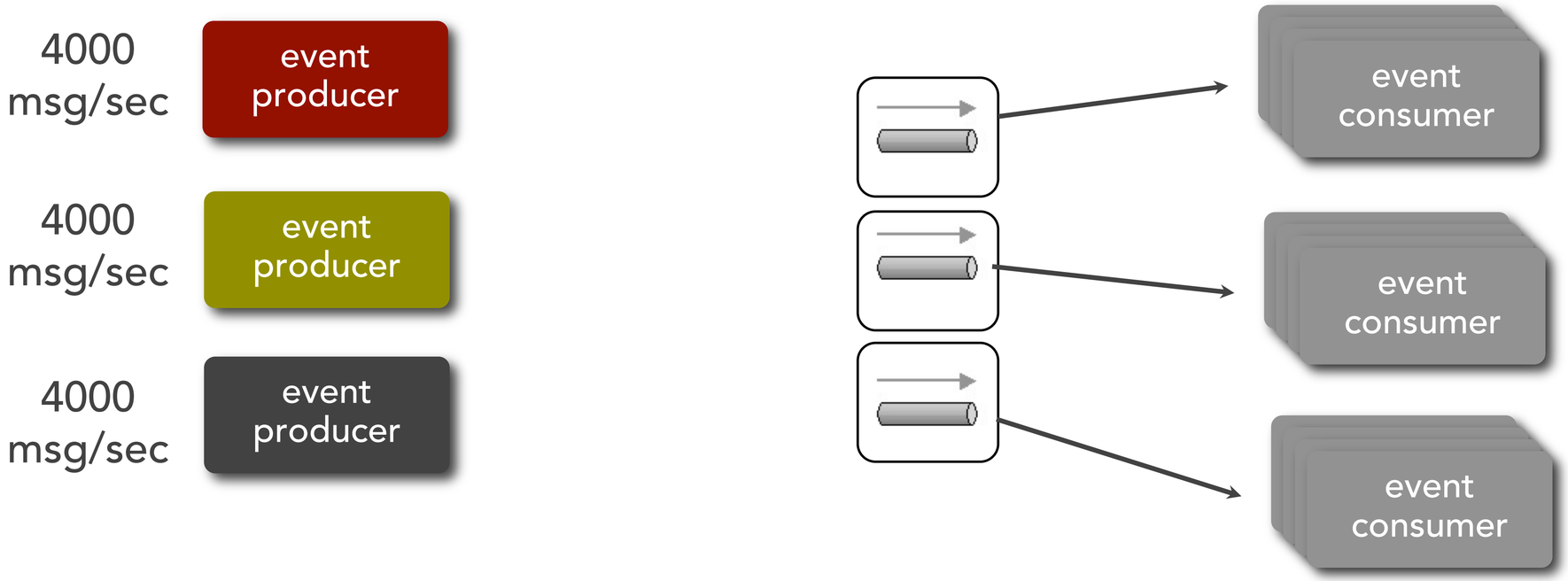

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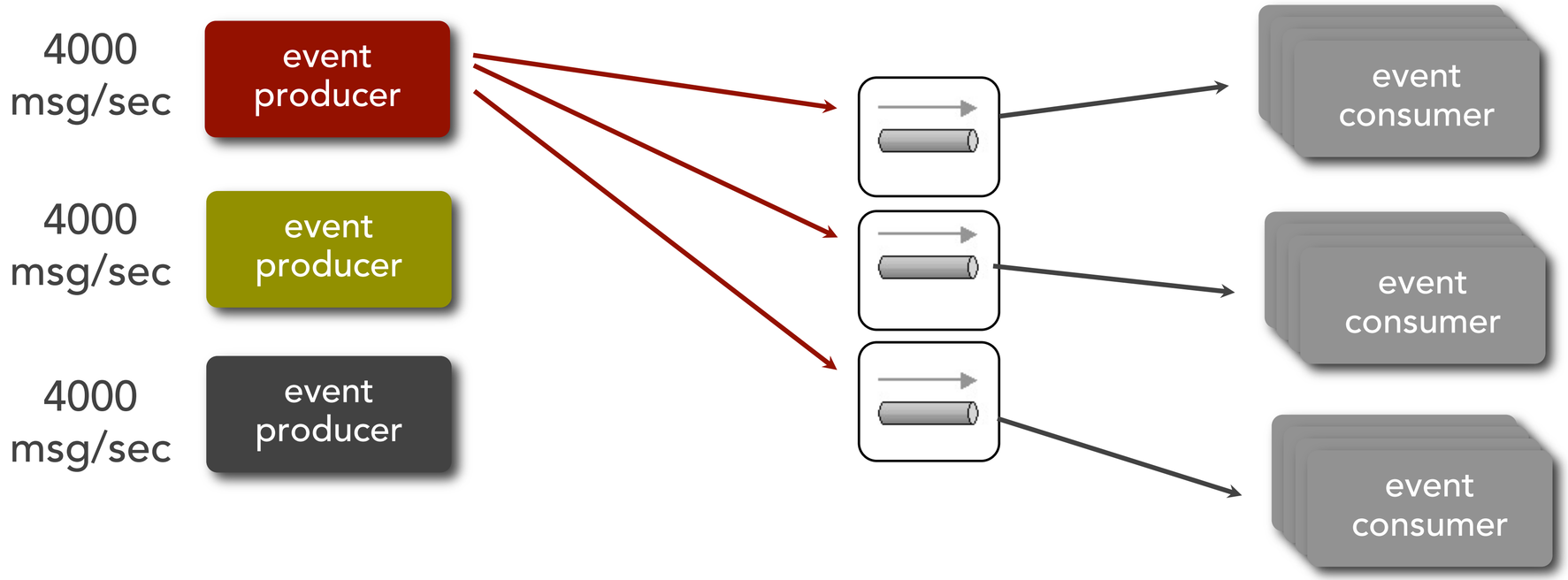

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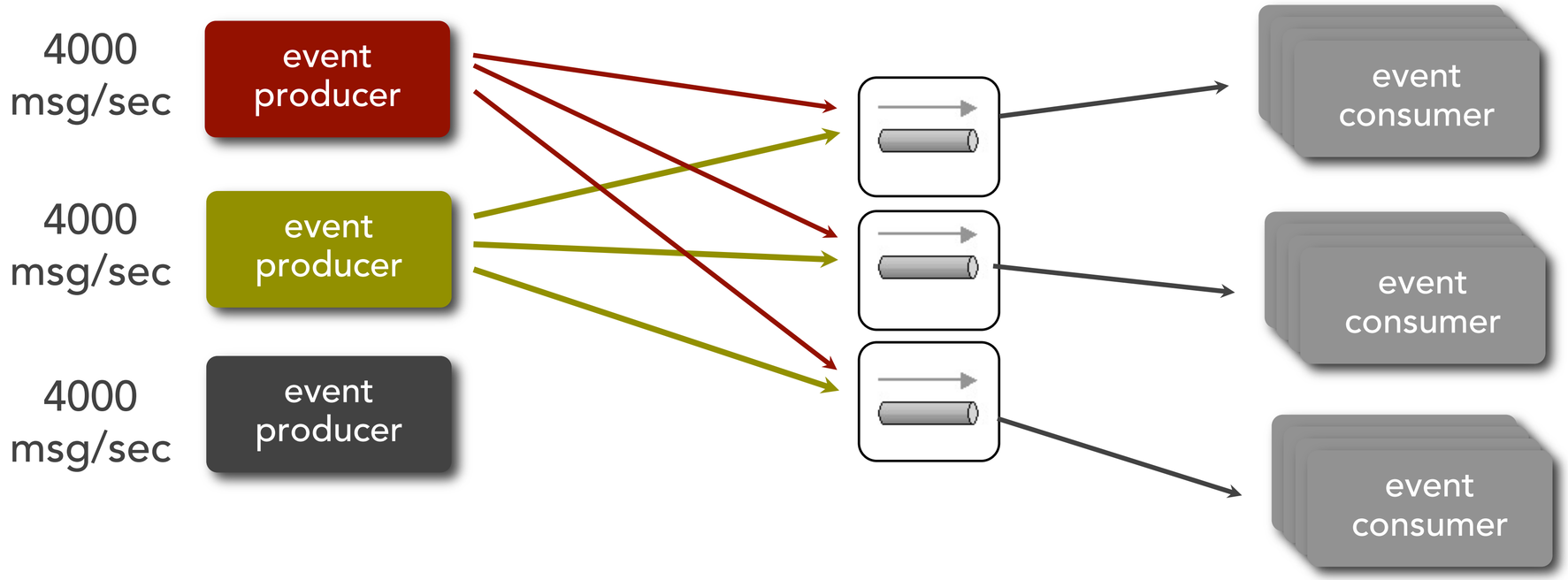

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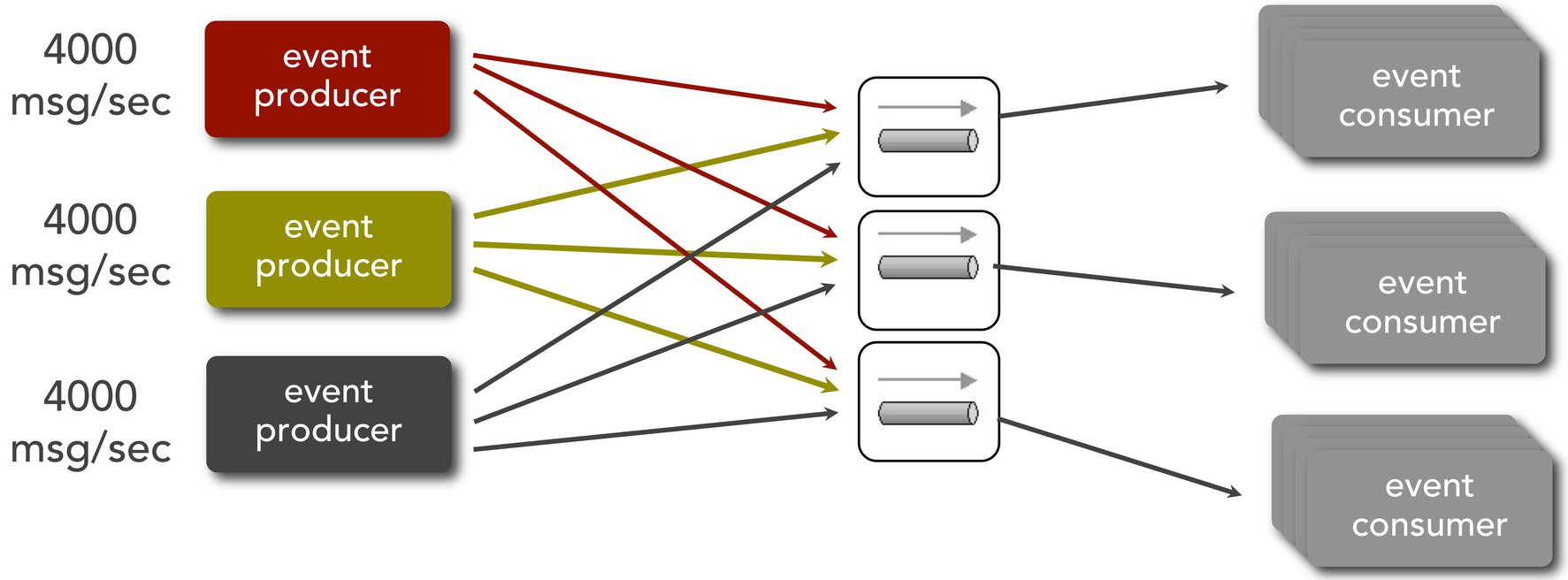

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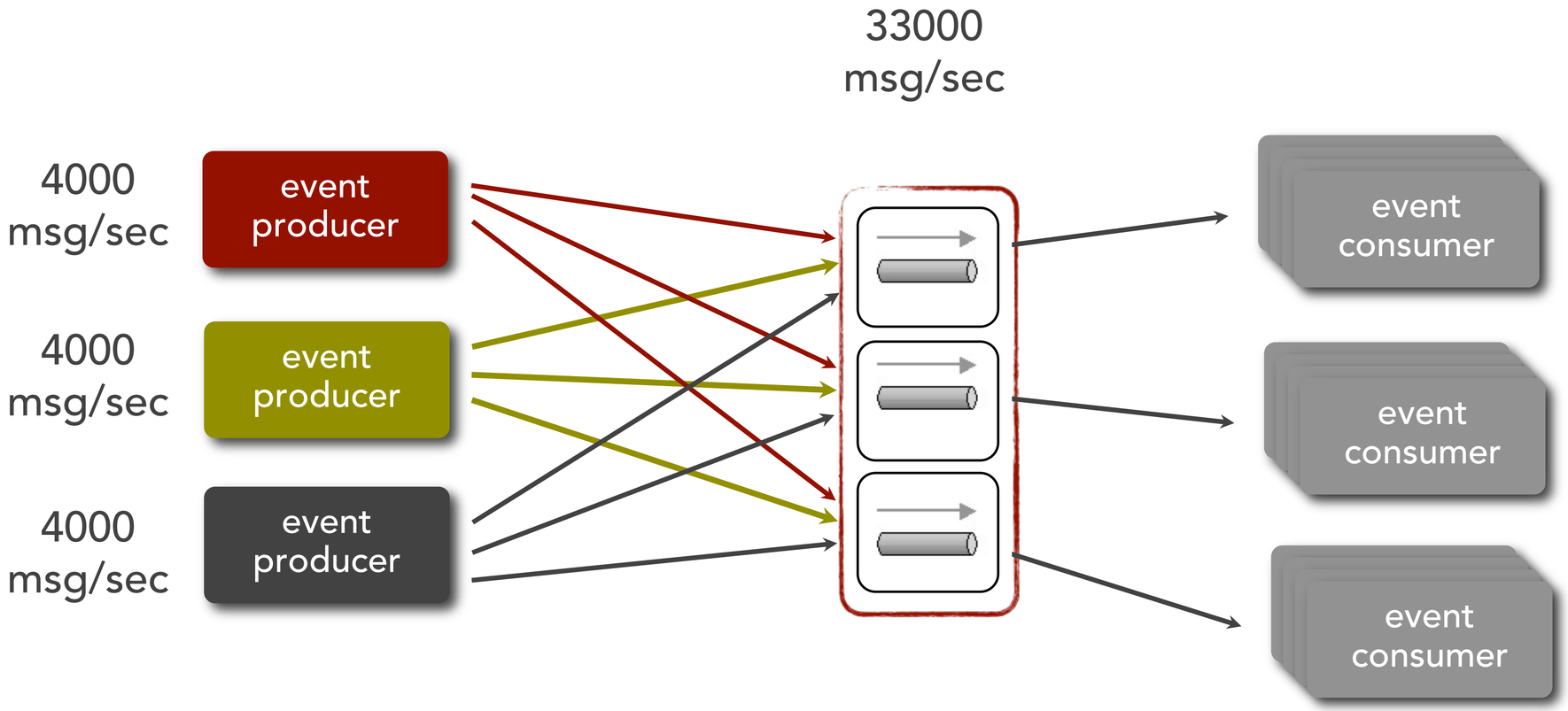

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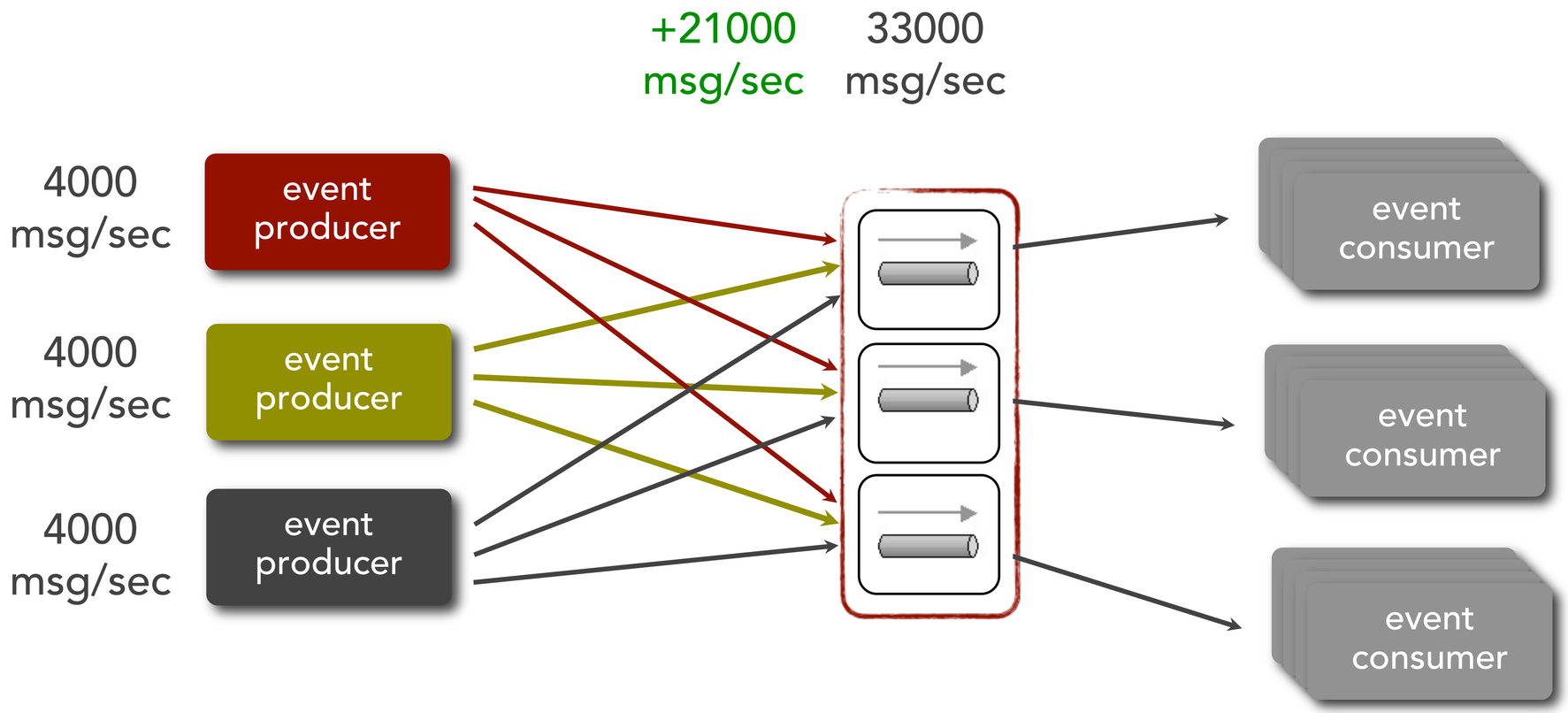
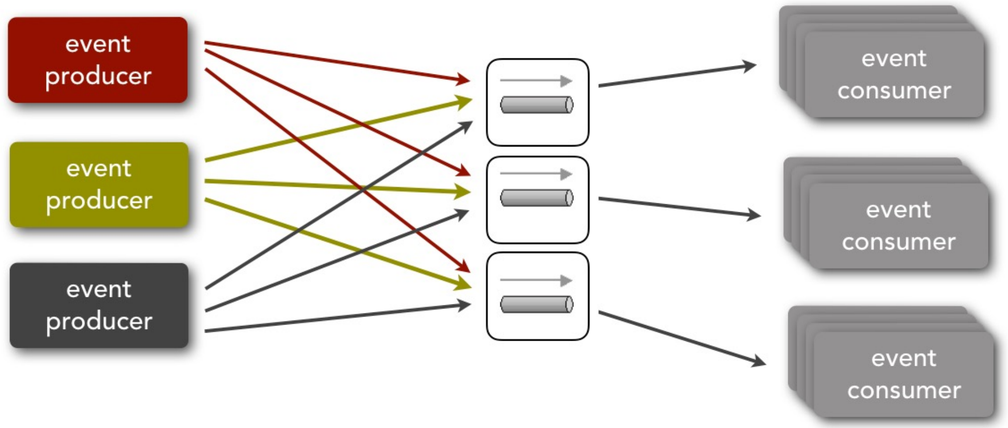
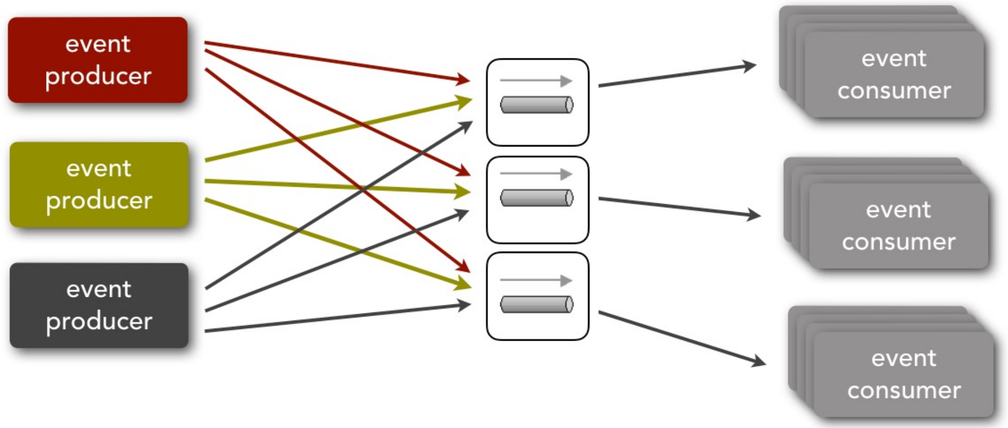


multi-broker pattern



multi-broker pattern



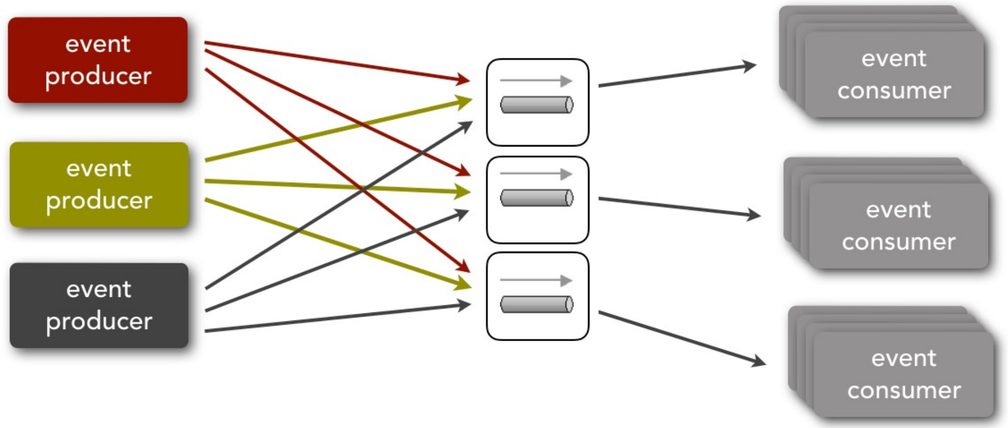
throughput

performance

scalability

capacity

multi-broker pattern



throughput

performance

scalability

capacity

complexity

cost

fifo message order

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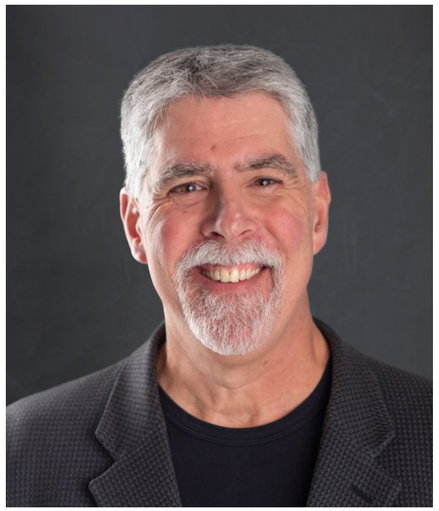
LIVE ONLINE TRAINING

Mastering Patterns in Event-Driven Architecture



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